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## ORIGINAL ARTICLES.

### I.—The Gigantic Ceratopsidæ, or Horned Dinosaurs, of North America.[1]

(PART II.)

By Prof. O. C. Marsh, Ph.D., LL.D., F.G.S., etc.

(PLATES IV.[2] and V.)

TWO years ago at the Bath Meeting of the British Association, I had the honour to present a paper in which I compared the principal known Dinosaurs of Europe with those of America.[3] In this communication I referred to some peculiar reptilian remains from the Gosau formation of Austria, and compared them with certain Laramie fossils from America, about which I hoped soon to have more definite information. As an indication of the rapidity with which knowledge of ancient life is advancing, it may be interesting to know what has been learned in two years concerning this single group of the remarkable reptiles known as *Dinosauria*. This group I have termed the *Ceratopsidæ*, and I shall refer especially to the forms I have recently investigated, and hope to describe more fully later on, under the auspices of the United States Geological Survey.

The geological horizon of the *Ceratopsidæ* in America is a distinct one in the Upper Cretaceous, and has now been traced nearly eight hundred miles along the eastern flank of the Rocky Mountains. It is marked almost everywhere by remains of these reptiles; hence I have called the strata containing them the Ceratops beds. They are fresh-water or brackish deposits, which form a part of the so-called Laramie, but are below the uppermost beds referred to that group.

The fossils associated with the *Ceratopsidæ* are mainly Dinosaurs, representing two or three orders, and several families. Plesiosaurs, Crocodiles, and Turtles of Cretaceous types, and many smaller reptiles, have left their remains in the same deposits. Numerous small mammals, also of ancient types, a few birds, and many fishes,

[1] Read before Section C of the British Association for the Advancement of Science, at the Leeds Meeting, September 4, 1890. See also American Journal of Science (3), vol. xxxvi. p. 477, December, 1888; vol. xxxvii. p. 334, April, 1889; vol. xxxviii. p. 173, August, 1889, p. 501, December, 1889; and vol. xxxix. p. 81, January, 1890, p. 418, May, 1890. [2] For Plate IV. see the April Number Geol. Mag.

[3] Report of the British Association for the Advancement of Science for 1888, p. 660. London. 1889. Abstract, American Journal (3), vol. xxxvii. p. 323, April, 1889. See also Geol. Mag. 1890, pp. 1–5, and Pl. I.

are likewise entombed in this formation. Invertebrate fossils and plants are not uncommon in the same horizon.

The Skull of one species was described and illustrated in the Geological Magazine for 1890 (Dec. III. Vol. VII. Pl. I. pp. 1–5), to which it will be sufficient to refer the reader. But the following notes, *supplementary* thereto, form part of the paper which appeared in the "American Journal of Science" for February, 1891. Additional figures of the skull have since been prepared and are given in Plates [1] IV. and V.

In the figures of *Triceratops flabellatus* (see Geol. Mag. 1890, Pl. I. Figs. 1, 2), it was pointed out that the rostral bone was free and was not secured (*op. cit.* p. 2), but, in another skull, represented in Pl. IV. Figs. 2, 3, 4, and 5, the rostral bone and nasal horn-core are in position, and firmly coössified with the adjoining elements.

The frontal bones are quite short, and early unite with each other and with the adjoining elements, especially those behind them. The frontal or central region of the skull is thus greatly strengthened to support the enormous horn-cores which tower above. These elevations rest mainly on the post-frontal bones, but the supra-orbitals and the post-orbitals are also absorbed to form a solid foundation for the horn-cores. These horn-cores are *hollow at the base* (see Pl. V. Fig. 1), and in general form, position, and external texture agree with the corresponding parts of the *Bovidæ*.

The post-frontal bones are very large, and meet each other on the median line. Posteriorly they join the squamosals and the parietals. At their union with the latter there is a median foramen (Pl. V. Fig. 1, *x*), which apparently corresponds to the so-called "parietal foramen." [2]

In old individuals it is nearly or quite closed. When open, it leads into a large sinus, extending above the brain-case into the cavities of the horn-cores. This foramen has not before been observed in Dinosaurs.

The palatine bones are much smaller than the pterygoids. They are vertical, curved plates, outside and in front of the pterygoids, and uniting firmly with the maxillaries. The vomers join the pterygoids in front, where they appear as thin bones, closely applied to each other.

The transverse bones give some support to the maxillaries, which are further strengthened by close union with the pterygoids. They meet the pterygoids behind, and the palatines in front.

The Brain.—The brain of *Triceratops* appears to have been smaller in proportion to the entire skull than in any known Vertebrate.

The position of the brain in the skull does not correspond to the axis of the latter, the front being elevated at an angle of about thirty degrees (Plate V. Fig. 2).

[1] Plate IV. appeared in the April Number, 1891; Plate V. is in the present Number.

[2] The name usually applied to this aperture is misleading, as in *Chamæleo* and some other reptiles the foramen is not in or near the parietal bones. It may more properly be called the "pineal foramen."

The brain-case is well ossified in front, and in old animals there is a strong septum separating the olfactory lobes.

Teeth of Triceratops.—The teeth of *Triceratops* and its near allies are very remarkable in having two distinct roots. This is true of both the upper and lower series. These roots are placed transversely in the jaw, and there is a separate cavity, more or less distinct, for each of them. One of these teeth from the upper jaw, represented by figures of the natural size (Plate V. Figs. 3–6), are typical of the group.

The teeth form a single series only in each jaw. The upper and lower teeth are similar, but the grinding face is reversed, being on the inner side of the upper series, and on the outer side of the lower series. The sculptured surface in each series is on the opposite side from that in use.

The teeth are not displaced vertically by their successors, but from the side. The crown of the young tooth, also with two strong roots, cuts its way between the alveolar margin and the adjacent root of the old tooth, sometimes advancing between the two roots, as might be expected.

The teeth in this family are entirely confined to the maxillary and dentary bones. The rostral bone, the premaxillaries, and the pre-dentary, are entirely edentulous.

Cervical and Dorsal Vertebræ.—The atlas and axis of *Triceratops* are coössified with each other, and at least one other vertebra is firmly united with them (Woodcut, Fig. 1). These form a solid mass, well adapted to support the enormous head. The cup for the occipital condyle is nearly round, and very deep. The rib of the second vertebra is coössified with it, but the third is usually free. The centrum of the fourth vertebra is free, and the remaining cervicals are of the same general form, all having their articular faces nearly flat (Woodcut, Fig. 2).

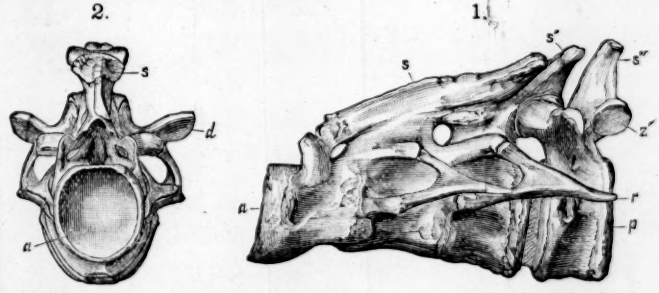


Fig. 1.—Anterior cervical vertebræ of *Triceratops porosus*, Marsh; side view.
Fig. 2.—Fourth cervical vertebra of same series; back view.
*a*. anterior face of atlas; *d*. diapophysis; *n*. neural canal; *p*. posterior face of fourth vertebra; *r*. rib; *s*. neural spine of axis; *s'*. neural spine of third vertebra; *s''*. neural spine of fourth vertebra; *z'*. posterior zygapophysis.

The anterior dorsal vertebræ have very short centra, with flat articular ends, and resemble somewhat those of *Stegosaurus*, especially in the neural arch (Woodcut, Figs. 3–4).

The posterior trunk vertebræ have also short, flat centra, but the diapophyses have faces for both the head and tubercle of the ribs, as in Crocodiles, a feature not before seen in Dinosaurs (Woodcut, Figs. 5–6).

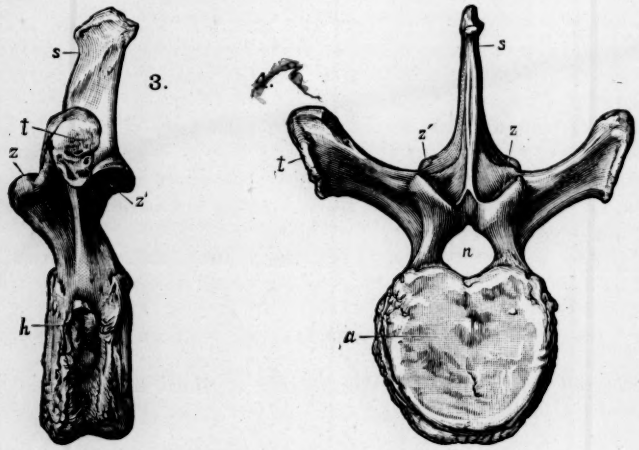


Fig. 3.—Anterior dorsal vertebra of *T. porosus* (side view).
Fig. 4.—The same vertebra (front view).

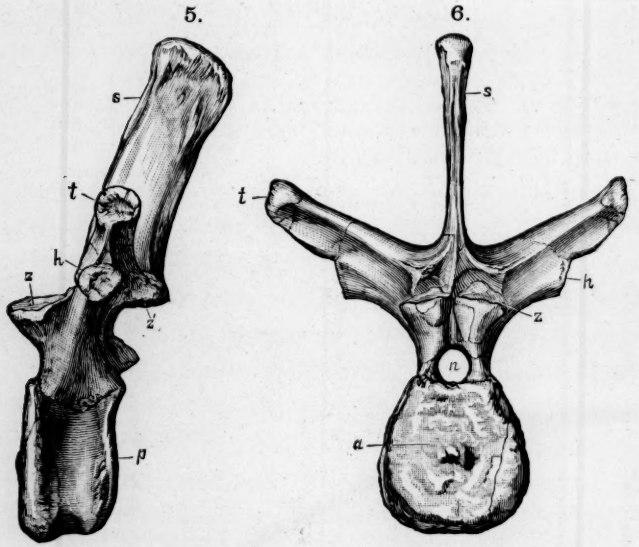


Fig. 5.—Posterior dorsal vertebra of same species (side view).
Fig. 6.—The same vertebra (front view).

The Sacrum.—The sacrum was strengthened by union of several vertebræ, ten being coössified in one specimen of *Triceratops* (Woodcut,

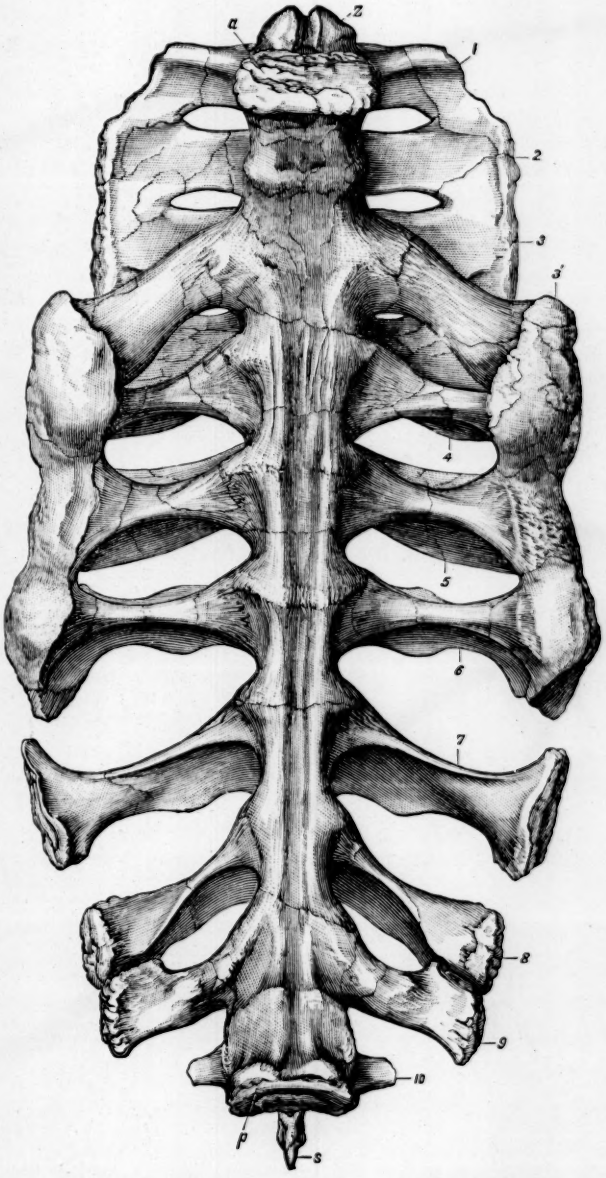


FIG. 7.—Sacrum of *Triceratops porosus*, Marsh,
(Seen from below, one-eighth natural size.)

*a*. anterior face of first sacral vertebra; *p*. posterior face of last sacral vertebra; *s*. neural spine of last vertebra; *z*. anterior zygapophysis of first vertebra; 1—10, transverse processes left side.

Fig. 7). The middle or true sacral vertebræ have double transverse processes, diapophyses being present, and aiding in supporting the ilium. This character has been seen hitherto, in the *Dinosauria*, only in *Ceratosaurus* and some other *Theropoda*.

The main support of the pelvis was borne by four vertebræ, which evidently constituted the original sacrum. In front of these, two others have only simple processes, and apparently were once dorsals or lumbars. Three vertebræ next behind the true sacrum have also single processes, and the fourth, or last of the series, has the rib process weak, and not reaching the ilium (Woodcut, Fig. 7). Seen from the side, the sacrum is much arched upward, and the neural spines of the true sacrum are firmly coössified. In the median region, the sacral vertebræ have their centra much compressed, but the last of the series are widely expanded transversely. The whole appearance of the sacrum is remarkably avian. The neural canal of the sacral vertebræ has no special enlargement, thus differing widely from that in *Stegosaurus*.

The Caudal Vertebræ.—The caudal vertebræ are short, and the tail was of moderate length. The first caudal has the anterior face of the centrum concave vertically, but flat transversely, and a short, massive neural spine with expanded summit (Woodcut Figs. 8–10).

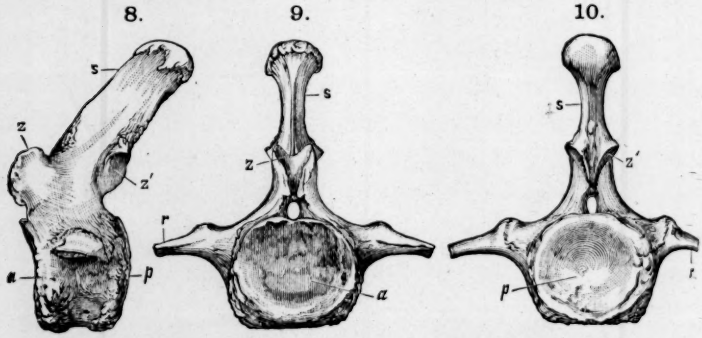


Fig. 8.—First caudal vertebra of *Triceratops prorsus*, Marsh; side view.
Figs. 9, 10.—Front and back views of same vertebra.

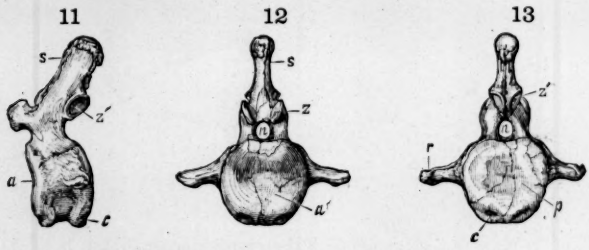


Fig. 11.—Median caudal of same species, side view.
Figs. 12, 13.—Front and back views of same vertebræ.
*a*. anterior face of centrum; *c*. face for chevron; *n*. neural canal; *p*. posterior face of centrum; *r*. rib; *s*. neutral spine; *z*. anterior zygapophysis; *z′*. posterior zygapophysis.

In the median caudals the centra have biconcave articular faces, and weak neural spines. The distal caudals are longer than wide, with the ends nearly round and concave.

Fig. 14.—More distal caudal of same species; side view.
Figs. 15, 16.—Front and bottom views of same vertebra.

Figs. 17-19.—Distal caudal of same species; side, front, and bottom views.
All the figures are one-eighth natural size.

## EXPLANATION OF PLATES.

PLATE IV.—(For Plate IV. see April Number Geol. Mag.)

Fig. 1. Skull of *Triceratops flabellatus*, Marsh (seen from behind).

Fig. 2. Skull of *Triceratops porosus*, Marsh; (seen from the front) *d.* dentary; *p.* parietal; *pd.* pre-dentary; *s.* squamosal; *e.* epoccipital; *h.* horn-core; *q.* quadrate; *h'.* nasal horn-core; *r.* rostral bone.

Figs. 1 and 2, one-twentieth natural size.

Fig. 3. Anterior part of skull of *Triceratops prorsus*, Marsh; side view; one-eighth natural size.

Fig. 4. Front view of same.

Fig. 5. The same; seen from below.
*h'.* nasal horn-core; *n.* nasal; *na.* narial aperture; *pm.* premaxillary; *r.* rostral bone.

Fig. 6. Pre-dentary of same individual; side view; one-eighth natural size.

Fig. 7. Bottom view.
*a.* anterior end; *b.* upper border; *d.* groove for dentary; *s.* symphysis.

Fig. 8. Top view of same specimen.

PLATE V.

Fig. 1. Skull of *Triceratops serratus*, Marsh; diagram; seen from above. *d.* epijugal bone; *f.* frontal; *fp.* postfrontal; *j.* jugal; *m.* maxillary; *n.* nasal; *pf.* prefrontal; *pm.* premaxillary; *x.* pineal foramen (one-twentieth natural size).

Fig. 2. Cast of brain-cavity of *Triceratops serratus*, Marsh; side view; one-half natural size.
*c.* cerebral hemispheres; *cb* cerebellum; *m.* medulla; *ol.* olfactory lobe; *on.* optic nerve; *p.* pituitary body.

Fig. 3. Maxillary tooth of *Triceratops serratus*; outer view; natural size.

Fig. 4. The same tooth; side view.

Fig. 5. The same tooth; inner view.

Fig. 6. The same tooth; seen from below.

(*To be continued in our next Number.*)

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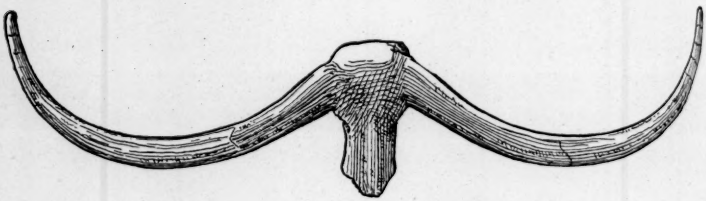
## II.—On Bubalus Bainii (Seeley).

By Professor H. G. Seeley, F.R.S., F.G.S., etc.

VERY little is known in England of the Tertiary deposits of South Africa. Some marine beds are found, as at Bathurst, where the limestone is full of teeth of *Carchadon* and *Lamna*, and shells of *Turritella Ostrea, Donax*, and *Lucina*. The shells are

preserved in the Albany Museum. I was informed that these beds are 300 to 400 feet above the sea. The teeth shown to me in their worn, polished, yellowish tone rather recalled the condition of Red Crag fossils.

All over the interior of the Colony freshwater Tertiary deposits have filled up ancient valleys, and sometimes existing rivers have cut channels for short distances through these accumulations. I noticed them sometimes to have been partially eroded and again filled up, before modern river denudation laid the existing sections bare. In these older muds and gravels are remains of a terrestrial fauna which no longer lives in Africa. I had no opportunity of determining its antiquity, or of making an approximate list of its fossils; but my attention was called by M. Peringuey to some of these remains in the South African Museum at Cape Town. Besides these newer Tertiary fossils, there are one or two which would be of exceptional interest if their African origin could be established.



Cranium of *Bubalus Bainii*, Seeley.

They are evidently very ancient acquisitions, and the circumstance that they are not mentioned by the elder Bain, and have no mark indicating presentation, refers them to a time too remote for tradition to be helpful. One is the middle portion of a mammalian skull with the teeth worn down to the alveolar margin, which seems to me to be the *Hippopotamus sivalensis* and the trustees have generously entrusted me with the specimen for determination. The skull is rather smaller than the Indian specimens in the British Museum, and the teeth are worn down to the alveolar border, so that characteristic details of dental structure are obliterated. The other specimen is the distal end of the femur and proximal end of the corresponding tibia of an enormous proboscidian. The extremities of these bones had a circumference of about 80 centim. They are as heavily mineralized as Karoo fossils with which they had become associated, and though free from matrix, are so like Siwalik specimens, that it is possible that they may have been brought from India. In this uncertainty I may mention that I once found in a newly unpacked collection of Dicynodont bones from South Africa in the British Museum, an undoubted Mammalian fragment, which was rejected as being a Siwalik fossil, which had accidentally dropped among the other bones. Still the possibility of such a fauna being represented at the Cape is of sufficient interest to justify this reference to specimens without a history.

Another mammalian fossil is better authenticated. In the Proceedings of the Geological Society of London, vol. iii. November 20th, 1839, the first evening communication was "Extract from a letter addressed to Dr. Andrew Smith by A. G. Bain, Esq., dated Graham Town, Cape of Good Hope, February 21st, 1839, and communicated by Charles Darwin, Esq. The object of this extract is to announce the discovery by Mr. Martin Smith of the piths and portions of the head of an ox in the alluvial banks of the Moddar, one of the tributaries of the Orange River, and 40 feet below the surface of the ground. The piths with the breadth across the os frontis measured 11 feet 7 inches, but it is calculated that 5 inches had been broken off the end of each tip; and the circumference of the piths at the root was 18 inches. The orbits were situated immediately under the base of the horns. Part of the upper jaw containing five molar teeth, and other fragments of the head, as well as a cervical vertebra, were found at the same time." With time Mr. Bain's estimate of the original size of the horn cores extended. For in the Trans. Geol. Society, series 2, vol. vii. p. 59, the specimen is again alluded to in a letter to Sir Henry de la Beche from Fort Beaufort, April 29, 1844. "From an alluvial deposit on the banks of the Moddar River, before noticed, there was obtained about five years ago the skull of a kind of Buffalo, retaining the bony cores of a pair of horns which it is calculated must have measured full fourteen feet from tip to tip when perfect. This fossil is now in Cape Town." In the same volume of the Geological Transactions, p. 192, is a final reference to another and apparently similar animal. Mr. A. G. Bain in a paper on the Geology of South Africa, read Nov. 15th, 1852, says, "I ought perhaps to mention that I have frequently heard of animal remains being discovered in the alluvium, differing from those of existing animals; and I discovered at Bloemhoff, in the Division of Graaf Reinet, about 10 feet below the surface, in a marly alluvial soil, some remains of an extinct ruminant, consisting of a skull, with the core of one horn attached, the former being of extraordinary length in proportion to its breadth. Its forms part of the collection of 1847 [sent to the Geological Society] and must speak for itself. I have no doubt a diligent search in the deep ruts or ravines which everywhere intersect the great plains of the interior would produce a vast number of extinct mammalian remains perfectly new to science."

What became of the second specimen is not evident, but I make no doubt that the former is the beautiful ornament which hangs from the gallery in the South African Museum at Cape Town, partly because Mr. Thomas Bain, who assisted in collecting specimens, has always believed that specimen to be his father's fossil, and partly because it agrees with Mr. Bain's description published in 1839. I therefore propose to name it *Bubalus Bainii*.

This Buffalo has the largest pair of horn cores known in the genus. They are remarkable not only for length, but for curvature; the horn bending first forward and then backward in a curve, which lies in one plane, which otherwise rather suggests the form and

curvature of Mammoth tusks. The transverse measurement in a straight line between the extremities of the horn cores, which are nearly parallel to each other, is 8 feet 6½ inches measured by M. Peringuey. But on the right side the curve extends 1½ inch further outward from the middle line of the skull than on the left side. M. Peringuey, of the South African Museum, had the kindness to verify for me Mr. A. G. Bain's measurement; and as now preserved the length along the posterior or concave curvature is 11 feet 1 inch, which corresponds sufficiently with 11 feet 7 inches obtained by Mr. Bain probably by taking the outer curve. The horn cores are also remarkably cylindrical, the flattening being moderate, a character of some interest when compared with the flattened form of the horn cores in the large *Bubalus palæindicus* of the Nerbudda. The face is long and narrow, rounded above the orbits, flattened from side to side and concave in length between the frontal and nasal region. The length of the head as preserved is 22½ inches, but with the slight restoration at the back of the head and the lost premaxillary prolongation in front it would be several inches longer. In general character this fossil approaches nearest to the South African Buffalo, so far as can be judged from its state of preservation; and it probably bears much the same relation to that type which the *Bos primigenius* of our own gravels and superficial deposits has to existing British cattle. It is not without interest to find that South Africa is no exception to the general law, that some of the existing races of animals have been preceded by allied species of larger size, as in Europe, South America, and Australia.

I am indebted to a grant from the Government Grant Fund of the Royal Society for the opportunity of identifying the specimen described fifty-two years ago by Mr. Bain. The figure is from a photograph taken for me by Mr. Allis, of Rosebank, Cape Town, and is on the scale of about one millimetre to the inch.

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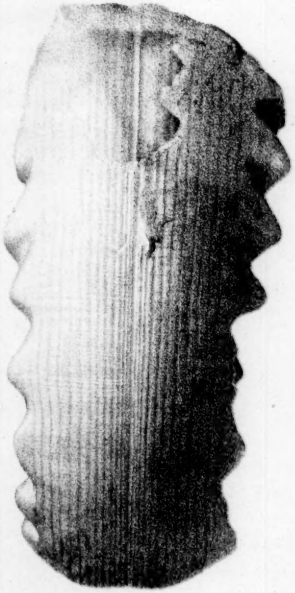
## III.—On the Genus *Léveillia* (*Porcellia*, Léveillé), with a Notice of a New Species from the Carboniferous Limestone of Ireland.

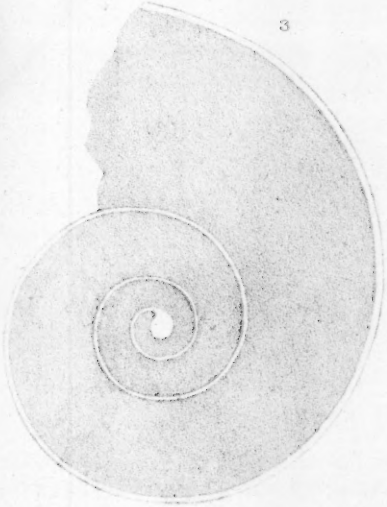
By R. Bullen Newton, F.G.S.,
of the British Museum (Natural History).

(PLATE VI.)

In 1835 M. Charles Léveillé[1] described a peculiar and extinct univalve shell under the name *Porcellia*, which he had discovered in the Carboniferous Limestone of Tournay in Belgium. Since that time the right of this name to stand has never been questioned, notwithstanding the fact of its pre-occupation by Latreille[2] in 1804, for an Isopodous Crustacean genus, and which he rendered *Porcellio*. As the retaining of two names so nearly alike, differing only in their terminal letter, must constantly lead to confusion in Natural History nomenclature, it becomes necessary to suggest an alteration, and

[1] Mém. Soc. Géol. France, 1835, vol. ii. part 1, p. 39.
[2] Hist. Nat. Crust. 1804, vol. vii. p. 45.




G.M. Woodward del. et lith.

West, Newman imp.

Léveillia latidorsata, *sp. nov.*
Carboniferous Limestone. *Ireland.*
(*nat. size.*)

*Léveillia* is therefore proposed to take the place of Léveillé's genus *Porcellia*.

I may state that my colleague Mr. E. A. Smith, F.Z.S., the Conchologist of the British Museum, warmly supports my action in this matter, and fully admits the justice and desirability of removing *Porcellia* from the list of molluscan genera.

Genus Léveillia, R. B. Newton, *nom. mut.*

*Porcellia*, C. Léveillé, 1835, *non* Latreille, 1804.

The chief characters of this genus may be briefly stated as:—Shell nearly symmetrical, monothalamous, discoidal, biconcave; whorls contiguous and on the same plane, except initial ones, which are slightly raised, and all exposed within a wide umbilicus; the dorsal area bears a narrow and centrally situated continuous band, or groove, which opens on the external part of aperture in a slit; aperture oval or quadrangular; surface structure beaded, ribbed, or spirally striated; umbilical margin round or angular, with a series of nodulations or quite plain; shell structure moderately thick.

The distinguished Belgian palæontologist, the late Prof. L. G. de Koninck, published some extended observations on this genus in 1843[1] and 1883,[2] giving a full synonymy and an emended description of the original diagnosis.

Two species were described by Léveillé in illustration of his genus, viz. *Puzo* and *lævigata*. The latter of these being without a slit, De Koninck removed to *Euomphalus* in 1843, and finally to the genus *Straparollus* in 1883, from which fact it is evident he considered the presence of the median band of the highest generic importance, although Léveillé failed to include it among his original characters, recognizing it as only of specific value in his description of *L. Puzo*, the type of the genus. The central position of this band divides the shell into two equal parts. With the growth of the shell the band becomes successively filled up until it reaches the aperture where it is still open to form the slit. The slit itself is often difficult to trace in specimens, but it is usually well seen in the weathered examples from Tournay. Its special function would no doubt be as in other fissured genera for the purpose of ejecting vitiated water from the branchial chambers of the animal.

*Generic affinities.*—In following the history of this genus we find that much misconception has arisen as to its proper position in the Mollusca. Many of its species have been ranked with the Cephalopoda under *Ammonites*, *Nautilus*, *Goniatites*, etc., though the total absence of septa or chambers is strong evidence against such determinations. Others have been described as *Schizostoma*, *Bellerophon*, and *Pleurotomaria*. With regard to the first of these genera, it may be stated that, possessing no slit, its other peculiarities need not be discussed. On examining *Bellerophon*, or genera known to be closely allied to it, we find it to be usually a heavy globose and convolute shell, with a wide and semilunar mouth,

[1] Desc. Anim. Foss. Ter. Carbonif. Belgique, 1843, p. 357.

[2] Faune Calc. Carbonif. Belgique, 1883, p. 112.

which often bears strong callosities on its inner margins. The continuous fissure is not, however, a persistent character, sometimes consisting of a regular series of isolated perforations, as in *Tremanotus* of Hall; in other species the central part of the dorsal area may be keeled or form a mere depression without apparently any connexion with the interior of the shell, until the lip is reached, when a deep notch is usually present. *Pleurotomaria*, especially its more depressed forms, i.e. *P. mirabilis*, Deslongchamps, presents more striking resemblances to our genus. The whole of the Pleurotomariidæ possess an uninterrupted slit, its position on the test varying greatly in different species. The *P. mirabilis* differs from *Léveillia* in being subdiscoidal and having a wide band excentrally situated, but its surface ornament is very similar in structure and arrangement.

De Koninck,[1] in his latest review of this genus, ranked it with the Haliotidæ, a family peculiar for shells bearing a regularly arranged series of siphonal openings on the *dorsum*. With this determination I am unable to agree, as the continuous slit or groove is decidedly a feature of much importance in our genus. The evidence would seem to justify us in uniting *Léveillia* with the Pleurotomariidæ, thus following the views first adopted by Dr. Ferd. Stoliczka[2] in 1868, afterwards by Mr. R. Etheridge, jun.,[3] in 1878, and Dr. Paul Fischer[4] in 1885. As *Léveillia* and *Bellerophon* have usually been considered to belong to the same family, viz. the Bellerophontidæ, it may not be out of place to examine the systematic position of the genus *Bellerophon* as now understood, it having been, at all times, a question of much dispute among Conchologists. This genus was first established by De Montfort[5] in 1808, and classed under the *Cephalopoda*.

De Blainville[6] in 1825, followed by John Fleming[7] in 1828, regarded it as a Tectibranchiate Gasteropod, and placed it in close proximity to *Bulla* and *Actæon*; but the peculiarities of these shells were so very obvious that this grouping never received much support. Deshayes,[8] in 1830, placed it with the Nucleobranchiata (Heteropoda), and this view has been more generally received than any other, though it seems somewhat anomalous when one considers the delicately formed and small shells of this group, their thin and transparent nature, and the invariable presence of an operculum. It may be observed that no operculum has yet been found in association with either *Bellerophon* or *Léveillia*. De Koninck's researches of 1843 led him to place both these genera among the Prosobranchiates, between *Capulus* and *Pleurotomaria*. The Bellerophontidæ were established by Professor M'Coy,[9] in 1852, as a family of Cephalopoda for the reception of *Bellerophon* only. Later, in 1855, in a further fasciculus of the same work (p. 558), *Léveillia*

[1] *loc. cit.* p. 10.
[2] Gasteropoda, Mem. Geol. Surv. India, 1868, p. 381.
[3] Cat. Australian Fossils, 1878, p. 87.
[4] Man. Conchyliologie, 1885, p. 848.
[5] Conchyl. Syst. 1808, vol. i. p. 51.
[6] Man. Malacology, 1825, p. 477.
[7] Hist. British Animals, 1828, p. 338.
[8] Encycl. Méthodique (vers), 1830, vol. i. p. 133.
[9] Syst. Desc. British Pal. Foss. 1852, p. 307.

(*Porcellia*) was also included in the family. In 1864, Prof. James Hall[1] described *Tremanotus*, a new Bellerophontoid genus, from the Niagara Limestone of Illinois, which possessed a regular series of siphonal openings on the dorsal region of the shell instead of the uninterrupted band. This discovery led to some valuable observations by the late Mr. F. B. Meek,[2] in 1866, who, grasping the importance of this unusual character in Prof. Hall's genus, looked upon it as the chief link of evidence required to prove the Prosobranchiate affinities of *Bellerophon*, and the desirability of associating it with the fissured shells of that group in close proximity to the Haliotidæ, Fissurellidæ, and the Pleurotomariidæ. It is satisfactory to note that Meek's decision in this matter is at last being recognized with favour, having been adopted by Prof. Karl Zittel[3] in 1882, Mr. R. Etheridge, jun.,[4] in 1882, De Koninck[5] in 1883, Dr. Paul Fischer[6] in 1885, and lastly by Messrs. Nicholson and Lydekker[7] in 1889.

*Distribution of Léveillia.*—Devonian, Carboniferous, and Triassic Rocks of various localities in England, Ireland, Scotland, Belgium, France, Germany, Russia, America and Australia.

The Triassic species are peculiar to Hallstatt and St. Cassian.

Léveillia (*Porcellia*) Puzo,[8] C. Léveillé, 1835.

Mém. Soc. Géol. France, 1835, vol. ii. pl. xi. figs. 10, 11, p. 39.

*Goniatites intercostalis*, J. Phillips, 1836.

Illust. Geol. Yorkshire, Part 2, Mountain Limest. District, 1836, pl. 20, figs. 61, 62, p. 237.

*Porcellia Puzo*, L. G. de Koninck, 1843.

Desc. Anim. Foss. Terr. Carb. Belgique, 1843, pl. 28, fig. 1, p. 359.
Faune Calc. Carb. Belgique, 1883, pl. 35, figs. 26–28, p. 116.

There is nothing to add to the characters of this type as originally defined by Léveillé, and which have been further added to by De Koninck. A notice of the species here is necessitated by the introduction of Phillips' *Goniatites intercostalis* into its synonymy for the first time. The brief description, as given by Phillips of this species stands thus: "Discoid, whorls costato-tuberculated on the sides, round on the back, with spiral intercostal striæ," and this is accompanied by two figures, one showing a side view with its nodulated whorls, the other exhibiting the size and shape of the aperture, both figures being taken from different specimens preserved in the "Gilbertson Collection," now arranged as one of the separate type

[1] Eighteenth Rept. Reg. Univ. New York, 1864, p. 347; Twentieth Rept. 1867, pl. xv. figs. 23, 24.

[2] Note on the Affinities of the Bellerophontidæ, Proc. Chicago Acad. Sciences, 1866, vol. i. p. 9.

[3] Handb. Palæontologie, 1882, p. 183.

[4] Proc. Roy. Phys. Soc. Edinburgh, 1882, vol. vii. part i. p. 73.

[5] *loc. cit.* p. 119.

[6] Man. Conchyliologie, 1885, p. 852.

[7] Man. Palæontology, 1889, ed. 3, vol. i. p. 767.

[8] For a fuller synonymy of this species the student is referred to De Koninck's works as here quoted.

series in the Geological Department of the British Museum (Natural History). The presence of the dorsal groove in these specimens, evidently overlooked by Phillips, together with the well-developed nodules bordering the umbilical margin, its highly ornamented surface and quadrangular-shaped mouth, leave no doubt as to its identification with this species.

*Formation and Locality.*—Carboniferous Limestone of Bolland. [Gilbertson Collection, British Museum.]

LÉVEILLIA LATIDORSATA (sp. nov.). Pl. VI.

*Specific characters.*—Shell large, discoidal, biconcave, last whorl massive and broad; umbilicus wide, deep, with prominent angular-shaped nodules, forming strong marginal serrations; nodules decrease in size towards the younger volutions of the whorls; the ventral surface of last whorl is deep, oblique and furnished with numerous transverse and closely set lines minutely beaded in structure, similar lines cross these concentrically on the younger whorls; dorsal region moderately convex and very broad near the aperture, but gradually diminishing in width towards the nucleus, ornamented with strong and broad ribs, which are crossed transversely by fine closely-set striæ; ribs with a slightly wavy contour and widest near the umbilical margins, decreasing in width and becoming straighter and more numerous as they approach each side of the median groove; aperture quadrangular; groove narrow and prominent; shell structure thick and robust.

DIMENSIONS.

| | | |
|---|---|---|
| Height ... ... ... ... | = 40 | millimetres. |
| Transverse diameter ... ... | = 72 | ,, |
| Height of mouth... ... ... | = 30 | ,, |
| Width of mouth ... ... ... | = 38 | ,, |
| Diameter of umbilicus ... ... | = 60 | ,, |

*Observations.*—This species is distinguished from all others by its large size, a lesser convexity, and greater width of the dorsal region, together with the presence of the broad and prominent ribs over the back instead of the spirally beaded surface. The important angular-shaped nodules, with the deep cavity between each, gives rise to a strongly serrated appearance, especially when the shell is viewed dorsally. Another peculiarity, only shared by one other species, viz. *L. Duponti*, De Koninck, is the fact that these nodules follow the dorsal plane of convexity and extend down the ventral surface only, without forming ridges by being produced over the back as is general in the nodulated species of the genus. The exception mentioned, though possessing this character, has a very differently shaped aperture, and its surface ornament presents the usual spirally beaded structure.

There are three specimens of our species in the British Museum, one of which has been sectioned to show the growth and contiguity of the whorls as well as to prove the monothalamous nature of the genus.

*Formation and Locality.*—Carboniferous Limestone, Dublin and Kildare. British Museum (Natural History).

References to the Described Species of *Léveillia*; those marked with an asterisk (*) being Represented in the British Museum (Natural History) Collections.

Trias.

*Léveillia* (*Schizostoma*) *Buchii*,* } Münster, 1841, Beit. Petrefactenkunde,
,, ( ,, ) *costata*,* } 1841, pl. xi. figs. 5, 6, pp. 105, 106.

*Locality*.—St. Cassian.

*Léveillia* (*Porcellia*) *Fischeri*, Hörnes, 1855. Ueber die Gastropoden und Acephalen der Hallstätter Schichten. Denksch. k. Ak. Wissen. Wien, 1855, vol. 9, part 2, pl. i. fig. 7, p. 45.

*Locality*.—Hallstatt.

Carboniferous.

Léveillia (*Porcellia*) armata, Murchison, Verneuil, and Keyserling. Géol. Russie Europe, 1845, vol. 2 (Paléontologie), pl. xxiv. fig. 3, p. 346.

*Localities*.—Orchard; Craigenglen; Craigie (Western Scotland), *vide* Armstrong, Young and Robertson's "Cat. Western Scottish Fossils," 1876, p. 58.

*Léveillia* (*Porcellia*) *carinata*, L. G. de Koninck, 1883. Faune du Calcaire Carbonifère de la Belgique, 1883, pl. xxxiii *bis*. figs. 27–31, p. 114.

*Locality*.—Tournay.

*Léveillia* (*Porcellia*) *Duponti*, L. G. de Koninck, 1883. *Loc. cit.* pl. xxxv. figs. 9–12, p. 118.

*Localities*.—Pauquys; Ireland (*var.*).*

*Léveillia* (*Porcellia*) *Le Honi*, L. G. de Koninck, 1883. *Loc. cit.* pl. xxxiii *bis*. figs. 32–36, p. 115.

*Locality*.—Tournay.

*Léveillia* (*Porcellia*) *mosana*, L. G. de Koninck, 1883. *Loc. cit.* pl. xxxv. figs. 13–16, p. 117.

*Locality*.—Visé.

*Léveillia* (*Porcellia*) *Puzo*,* C. Léveillé, 1835. Aperçu Géologique de quelques localités très riches en coquilles sur les frontières de France et de Belgique.—Description des coquilles, Mém. Soc. Géol. France, 1835, vol. 2, part 1, pl. ii. figs. 10, 11, p. 39.

*Localities*.—Bolland; Visé; Tournay.

*Léveillia* (*Bellerophon*) *Verneuili*,* D'Orbigny, 1838. Hist. Nat. Céph. ácetab. 1838, pl. vi. figs. 12–14, p. 212.

*Localities*.—Bolland; Visé.

*Léveillia* (*Nautilites*) *Woodwardi*,* W. Martin, 1809. Petrefacta Derbiensia, 1809, pl. xxxv. figs. 4, 5, p. 17.—Mineral Conchology, 1827, pl. 571, fig. 3.—Rech. Foss. Pal. Nouv.—Galles Sud (Australiæ), 1876, pl. 23, fig. 8, p. 319 (De Koninck).

*Localities*.—Bolland; Winster, Derbyshire; Visé. The original type of this species was refigured by James de Carle Sowerby in the Mineral Conchology, 1827. It now forms part of the "Sowerby Collection," arranged in the Type Gallery of the British Museum. An interesting fact in its distribution is De Koninck's record of its occurrence in the Carboniferous rocks of Burragood, New South Wales.

Devonian (European).

*Léveillia* (*Porcellia*) *calceolæ*, F. A. Rœmer, 1866. Beitrage zur geologischen Kenntniss des nordwestlichen Harzgebirges.—Palæontographica, 1866, vol. 13, pl. 33, fig. 6, p. 205.

*Locality*.—Hartz.

*Léveillia* (*Porcellia* ?) *cincta*, Münster, 1840. *Loc. cit.* 1840, p. 84 (not figured).

*Locality*.—Elbersreuth.

*Léveillia* (*Bellerophon*) *cultrata*, D'Orbigny, 1838. *Loc. cit.* pl. 7, figs. 21–23, p. 208.

*Locality*.—Eifel.

*Léveillia* (*Bellerophon*) *Edouardii*, D'Orbigny, 1838. *Loc. cit.* pl. 7, figs. 6, 7, p. 215.

*Locality*.—Eifel.

*Léveillia* (*Porcellia*) *parvula*, Münster, 1840. *Loc. cit.* 1840, p. 84 (not figured).

*Locality*.—Elbersreuth.

*Léveillia* (*Ammonites*) *primordialis*,* Schlotheim, 1820. Petrefactenkunde, 1820, p. 65.—Merkwürdige Versteinerungen, 1832, pl. ix. fig. 2, p. 16. (?) *Schizostoma carinatum*, F. A. Rœmer, 1850. Beit. geol. Kenntniss nord. Harz. 1850, pl. v. fig. 28, p. 38.

*Locality*.—Winterton, near Grund, Harz. Römer's species appears to be the immature form of *L. primordialis*.

*Léveillia* (*Bellerophon*) *radiata*, D'Orbigny, 1838. *Loc. cit.* pl. 6, figs. 20–23, p. 216.

*Locality*.—Eifel; Russia.

*Léveillia* (*Nautilites*) *Woodwardi*, W. Martin, 1809, *loc. cit.*
,, (*Bellerophon*) *Woodwardi*, J. Phillips, 1841. Fig. Desc. Palæozoic Foss. Cornwall, Devon, etc., 1841, pl. 40, fig. 201, p. 107.

*Locality*.—Newton, South Devon.

DEVONIAN (American).

*Léveillia* (*Porcellia*) *crassinoda*, C. A. White and R. P. Whitfield, 1862. Observations upon the Rocks of the Mississippi Valley which have been referred to the Chemung Group of New York, together with Descriptions of New Species of Fossils from the same horizon at Burlington, Iowa. Proc. Boston Soc. Nat. Hist. 1862, vol. 8, p. 303 (not figured).

*Locality*.—Burlington, Iowa.

*Léveillia* (*Porcellia*) *Hertzeri*, J. Hall, 1876. Illustr. Devonian Foss. 1876, pl. xvi. fig. 24. Nat. Hist. New York (Palæontology), 1879, vol. v. part 2, pl. xvi. fig. 24, p. 126.

*Locality*.—Columbus, Ohio (Upper Helderberg).

*Léveillia* (*Gyroceras* and *Porcellia*) *nais*, J. Hall, 1862. Descriptions of New Species of Fossils from the Upper Helderberg, Hamilton and Chemung Groups. Fifteenth Ann. Rep. Regents New York, 1862, part D. pl. 6, figs. 5, 6, p. 68.

*Locality*.—Chemung Co. (Chemung Group).

*Léveillia* (*Porcellia*) *obliquinoda*, C. A. White, 1862. Description of New Species of Fossils from the Devonian and Carboniferous Rocks of the Mississippi Valley. Proc. Boston Soc. Nat. Hist. 1862, vol. ix. p. 21 (not figured).

*Locality*.—Burlington, Iowa (Chemung Beds).

*Léveillia* (*Porcellia*) *rectinoda*, A. Winchell, 1863. Descriptions of Fossils from the Yellow Sandstones lying beneath the "Burlington Limestone" at Burlington, Iowa. Proc. Ac. Nat. Sci. Philadelphia, 1863, p. 18 (not figured).

*Locality*.—Burlington, Iowa.

## EXPLANATION OF PLATE VI.

FIG. 1. *Léveillia latidorsata* (R. B. Newton), ventral view of specimen, showing the nodulations and the wide umbilicus. The internal volutions are much covered with matrix.

FIG. 2. Dorsal view of same specimen showing the prominent ribs, the median groove, and the strong marginal serrations. The shell fracture a short distance from the margin of the mouth opening exposes impressions of the ribs and groove in the matrix.

FIG. 3. Internal section of another specimen of the same species showing the thickness of the shell, the contiguity of the whorls and its globular nucleus. The figure also illustrates the monothalamous nature of the genus.

The figures are drawn of the natural size.

## IV.—Note on the Age and Ancient Glaciers of the Himalayas.

By W. T. Blanford, LL.D., F.R.S., etc.

I DO not think geologists who have studied the Himalayas will be disposed to agree with Mr. Howorth (*ante*, pp. 97–104, 156–163) that those mountains have come into existence since the time when the Mammoth flourished in Siberia. It is quite possible that the Himalayas are higher now than they were in Pliocene or even in Pleistocene times; but the geological evidence, so far as it is known, is, I think, in favour of the view expressed by Mr. R. D. Oldham in the Geological Magazine for February (*ante*, pp. 72–73). This view is that the period of elevation has approximately coincided with the Tertiary era. The Upper Pliocene beds along the southern border of the range so closely resemble in material and coarseness those forming in the same area at the present day as to indicate very similar geographical conditions, and Mr. H. B. Medlicott showed, many years ago, that where the great Himalayan rivers flow now, great rivers have flowed since early Pliocene times at least. The principal question in dispute amongst recent investigators of Himalayan Geology has been whether the range existed in Pre-Tertiary times or not. Mr. Howorth's contention that the elevation of the Himalayas is Pleistocene (or, as some geologists call it, Post-Tertiary) has the very great merit of novelty.

Mr. Howorth's principal argument for the recent origin of the Himalayas is founded on the absence of ice-markings on a large scale. On this subject he has brought together a remarkable mass of evidence. It is difficult, without writing a paper of considerable length, to pick out the weak points in this evidence, and to show how much may be said on the other side. I will give one example of each form of reply.

One of Mr. Howorth's principal witnesses, perhaps I should say his principal witness, is the late Mr. J. F. Campbell. Now Mr. Campbell's main object in the paper quoted was to demolish certain rather extravagant ideas, held only by a few extreme glacialists, about polar ice-caps extending to the tropics and similar hypotheses. As a matter of fact, Mr. Campbell never entered the main Himalayan range; he only went to three or four hill-stations on the outer spurs.

On the other hand, Mr. Howorth has overlooked evidence by geologists who really traversed the main range. The only part of the higher Himalayas that I have been able to examine is to the eastward in Sikkim. Here, more than forty years ago, Sir J. Hooker described great moraines in every Himalayan valley that he ascended, at or about 7000 or 8000 feet elevation (Himalayan Journals, vol. i. p. 380). I found the same, and can entirely confirm Sir J. Hooker's observations. The Lachoong and Lachen valleys (which unite to form the Teesta) have, above the lowest moraines, the U-shape and other characteristics of glacier valleys. At the present day, in this part of Sikkim, no glaciers descend below 14,000, and very few below 16,000 or 17,000 feet. Thus great glaciers, in this part of the Himalayas, descended in Pleistocene times from 6000 to 10,000 feet lower than they do now. In

Kashmir, according to Drew and Lydekker (Mem. Geol. Surv. Ind. vol. xxii. p. 32), the case is very similar. In short, so far as I can see, the extension of the glaciers in the Himalayas was very similar to what it was in the Alps; but as the latter are from 15° to 20° farther north, the glaciers came to the base of the mountains, and flowed over some of the adjacent country, whilst in the Himalayas all the ice melted within the range.

The only other fact cited by Mr. Howorth is the curious occurrence of remains of fossil Horses, Bovines, Rhinoceroses, etc., in Hundes. Here, too, I think he has overlooked part of the evidence, as he evidently is under the impression that none of the animals mentioned, Horse, Ox, Deer, Rhinoceros, and Elephant, can live at such elevations as 15,000 feet. The fact is, however, as Mr. Lydekker has shown, that wild horses (*Equus hemionus*) and Oxen (or rather Yaks, *Bos grunniens*) do inhabit Hundes at the present day, that the supposed Deer are Antelopes belonging to the genus *Pantholops*, peculiar to the Tibetan plateau, and that the only difficulty is about the Rhinoceros (the occurrence of *Elephas* is doubtful, I believe). The beds containing the remains are now regarded by Mr. Lydekker (Rec. Geol. Surv. Ind. 1887, p. 54) as Pliocene, not Pleistocene. It is probable that these beds have undergone a certain amount of elevation; but if I were obliged to decide which is more improbable, that a Rhinoceros in Pliocene times lived 15,000 feet above the sea, or that the Tibetan plateau has been raised to that elevation from near the sea-level since the Pliocene period, I should feel very little difficulty in coming to a conclusion.

I am not prepared to accept all Mr. J. F. Campbell's views as to the Himalayas, but there is one remark in his paper with which I thoroughly agree. He infers from the circumstance that what he calls the "waterfall zone" lies close to the sources of the rivers, that the watercourses in the Himalayas are very old. I think if Mr. Howorth had had an opportunity of seeing what is perhaps the grandest example of subaërial denudation in the world, he would be as little inclined as I am to believe that such gigantic furrows as the Himalayan valleys can have been ploughed out by rain and rivers since the frozen Mammoths were imbedded in the gravels of the Siberian tundras.

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## V.—Note on the Expansion Theory of Mountain-Evolution.

By Charles Davison, M.A.;
Mathematical Master at King Edward's High School, Birmingham.

THE following is the fundamental principle of the theory of terrestrial evolution which has been sometimes called the "expansion theory":—

Masses of sediment laid down in an area of subsidence are gradually lowered to regions of the earth's crust that are at a higher temperature than that in which they were deposited. The sediment, being heated, expands, is crumpled and folded internally, and,

bulging up at the surface, is reduced by denudation to the form of a mountain-chain.

This theory has at different times received attention from geologists, and it has met with a considerable amount of adverse criticism. Much of that criticism appears to me of a very forcible character, but one of the strongest objections that can be brought against the theory does not seem to have been generally noticed.[1]

It is obvious that the heat which passes into and expands the sediment must be withdrawn from the immediately adjoining parts of the earth's crust, partly laterally, but chiefly from below; and that the amount of heat gained by the sediment must be equal to that lost by the crust. The increase in volume of the sediment must therefore be accompanied by an equal decrease in volume of that part of the crust from which the heat has been derived. Thus, the sediment in expanding must follow a crust that is retreating, and this retreat must take place, partly laterally, but chiefly downwards. Instead, then, of the sediment bulging up at the surface, and ultimately forming a mountain-chain, its uppermost layer must remain practically stationary (so far as the effect of the transference of heat alone is concerned), while most, if not nearly all, of the sediment below must subside.

It may, in reply to this, be urged that the sediment will check for a time the natural outward flow of heat from the earth's interior, while the heat will continue to pass as before through the other parts of its surface which are not areas of sedimentation. This may be the case, but the amount of heat so checked cannot be great. Supposing no heat at all to escape for some time through the sediment, then its effect in raising the surface of the mass relatively to that of the earth, can at the very most be represented by the diminution of the earth's radius during that time; and this diminution will be small. The actual relative elevation of the surface of the sediment, if there be any, will of course be very much less than the change of radius.

It follows, then, that the expansion theory is a theory of subsidence, rather than a theory of elevation.

## VI.—On a Microsaurian (*Hylonomus Wildi*, sp. nov.) from the Lancashire Coal-field.

By Arthur Smith Woodward, F.G.S., F.Z.S.

During a recent examination of a collection of fossils made by Mr. George Wild in the Burnley Coal-field, Mr. John Ward, F.G.S., recognized a novelty in the small Microsaurian which forms the subject of the following notes. The specimen was forwarded

[1] It has not, however, been overlooked by the Rev. O. Fisher. "The heat conducted into the new deposits," he remarks, "must be abstracted from the couches beneath, so that there can be no absolute increase in the amount of heat beneath the area in question except such as is supplied to it laterally, so that the process must be excessively slow" (Physics of the Earth's Crust, second edition, p. 132). I am indebted to my friend Mr. Fisher for drawing my attention to this paragraph, which, with the exception of the last few words, contains in a condensed form the argument that follows.

to the British Museum for determination, and a detailed study of its characters proves it to represent a Microsaurian family that has not previously occurred in the Carboniferous of Europe.

The fossil was obtained from the roof of the "Bullion Coal" at Trawden, near Colne, and comprises the head, abdominal region, and base of the tail of a small animal, occupying the whole of an elongated split nodule 0·08 m. in length. The jaw cannot have measured less than 0·017 in length, and the distance between the two pairs of limbs must have been about 0·036. There are also indications that the trunk was comparatively robust, and also somewhat laterally compressed.

Of the *head*, no recognizable portions remain beyond the mandibular rami. The ramus of the left side, imperfect at both extremities, is shown of twice the natural size from the inner aspect in Fig. 1, *md.*, and exhibits some of the conical teeth, which, though robust, have a very large pulp cavity with the walls apparently not folded even at the base. The axial skeleton of the trunk is also unsatisfactorily preserved, the remains of *vertebræ* merely indicating that they were well ossified and not permitting the determination of their characters. Portions of some of the anterior *ribs* (Fig. 1, *r*) prove their stoutness, with an expansion both proximally and distally; but whether they possessed a distinct head and tubercle cannot be determined. Traces of the posterior abdominal and caudal ribs suggest that these were comparatively slender.

The *interclavicle* (Fig. 1, *i. cl.*) is relatively large, and seems to have been rhomboidal in form, though the margins are not well

FIG. 1.—*Hylonomus Wildi*, sp. nov.: outlines of bones and dermal scutes.—Coal-measures, Trawden, near Colne. *d.* dorsal scutes; *f.* femur; *i. cl.* interclavicle; *il.* ilium; *md.* mandibular ramus; *r.* anterior ribs (only partially exposed); *v*, *v*¹. ventral scutes. All the figures of twice the natural size, except *v*¹., which is enlarged four times.

shown. It must have been at least as long as broad, and the exposed surface is distinctly ornamented with radiating rugæ and furrows. Of the pectoral limb there are only obscure indications. In the pelvic arch and limb, however, some of the bones are recognizable, notably the left ilium and femur. The *ilium* (Fig. 1, *il.*) is vertically elongated, with a short expansion below, a mesial constriction, and a gradual widening towards the truncated upper extremity. At its base, part of a thin laminar bone probably represents the ischium. The ilium is almost as long as the *femur* (Fig. 1, *f.*), which, though fractured and perhaps in side view, seems to be comparatively

slender, and must have been terminated at each extremity by unossified cartilage. The *tibia* (? or fibula) also appears to have been slender, equalling about one-half the length of the femur; but its outline is not satisfactorily shown.

The dermal *scutes* cover the whole of the trunk so far as preserved, all being oval in shape, deeply imbricating, and exhibiting prominent concentric lines of growth. Those of the ventral armour (Fig. 1, *v.*) are much larger than those of the dorsal (*d.*); and the former, when magnified ($v^1$.), show feeble radiating lines either superficial or structural.

The fossil thus described may be assigned without much doubt to the Microsaurian family of Hylonomidæ as restricted by Fritsch.[1] So far as known, indeed, it cannot be separated from the type genus *Hylonomus* itself. The general proportions are similar, and there are the same indications of the laterally compressed form of the trunk; while the relative stoutness of the anterior ribs will also doubtless be proved to characterize the typical species from Nova Scotia when sufficiently well preserved examples are discovered.[2] The closely allied genus *Hyloplesion* of Fritsch[3] is distinguished by its short interclavicle with a long posterior process, by its more slender anterior ribs, and by the relatively smaller size of the ilium; and the remaining genera are excluded from comparison by equally obvious characters. Upon present evidence it is thus proposed to regard the Microsaurian from the Lancashire Coal-Measures as a species of *Hylonomus*; and as this appears to be new, it may appropriately bear the name of *H. Wildi*, in honour of its discoverer, Mr. George Wild, whose long-continued researches in the Burnley Coalfield, especially in connection with the Carboniferous Flora, are well known. Among distinctive specific characters may be enumerated the form and proportions of the mandible and dermal armour; while the precise contour, size, and ornament of the interclavicle will not improbably prove to be of diagnostic value when this element is discovered in the several species from Nova Scotia.

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## VII.—Observations on a Keuper Conglomerate and on a Breccia, both Recently Exposed in the Neighbourhood of Bristol.

By T. Stock, Esq.

1. *A conglomerate in the Keuper.*—Whilst a drain was being cut in Argyle Street, joining Upper and Lower Eastvilles, one of the upper beds exposed consisted of a rather fine conglomerate, made up largely of rolled quartz pebbles of small size, compacted with rounded quartz sand and intermixed with coloured fragments (generally very small flakes) of softer shale or clays. I did not measure the thickness very carefully, but I should think that it did not exceed

[1] A. Fritsch, Fauna der Gaskohle, vol. i. p. 159.

[2] Sir J. W. Dawson, Geol. Mag. [3] Vol. VIII. p. 152.

[3] A. Fritsch, *tom. cit.* p. 160. *Hyloplesion* is considered to be identical with *Hylonomus* by Credner (Zeitschr. deutsch. geol. Ges. vol. xxxvii. p. 734); but this identification is very doubtful, as lately remarked by Sir J. William Dawson (Geol. Mag. [3] Vol. VIII. p. 153).

six inches, and as the drain is now filled up, the means of more accurate measurement are lost. The distance from the nearest denuded edge of the Coal-measures is as nearly as possible half a mile. Also, in making a drain-cutting in Heath Street, connecting the two Eastvilles, and about a quarter of a mile nearer Stapleton than the last, but about the same distance from the Coal-measures, another conglomeratic bed was exposed, in which, however, the quartz pebbles were smaller. As the Keuper beds lie horizontally, or nearly so, in this district, the second bed may be a continuation of the first, the altitudes being approximately similar. There is nothing to show that this conglomerate differs much from most others, in respect of derivation, being probably composed of the worn-down materials of preexisting formations, of rocks perhaps for the most part of Coal-measure age. The fineness of the conglomerate would naturally be attributed to its greater distance from the shore. The traces of green clay or shale may be referred with some probability to the Coal-measure shales, which are often variegated in this vicinity and highly coloured, as may be seen in the section at the Easton Brickworks and elsewhere. Apart from the question of conglomerates, I think I have evidence, which requires however to be carefully weighed and reexamined, of the using up of contemporary materials, in the formation of certain Jurassic and Coal-measure shales, in which there was, as is well known, frequent subsidence and elevation. The evidence to which I refer is a few instances in Somersetshire and Gloucestershire of well-preserved fossils occurring upon natural casts of fossils, and the occurrence of what I believe are pebbles of coal.

I may also mention that I have obtained or seen a good many quartz pebbles in the Rhætic bone breccia at Aust; but as I have not access to much of the literature of the Rhætic, I cannot say whether the fact has been noted or not by others before.

2. *A Dolomitic? Breccia in the parish of Alveston, Gloucestershire.*—My friend Mr. Olive, of Greenhill, lately drew my attention to an interesting little section exposed whilst making a boundary-wall on his property. It consists of a series of thin beds lying horizontally, the upper ones being much brecciated, the thick basement bed being homogeneous. The included fragments of the neighbouring Carboniferous Limestone are distinctly angular, being in fact distinctly a breccia, and not a conglomerate. One would naturally suppose that this must be an outlier or continuation of the neighbouring dolomitic conglomerate, which is marked on the Geological Survey Map as running up triangularly to near this spot. If so, it is interesting as an example of a conglomerate passing into a breccia, on account of its closeness to neighbouring Carboniferous Limestone cliffs. The bedding is also interesting, as also its (apparent) horizontality. I do not feel sure whether it may not be a breccia of later age. The matrix is apparently dolomitic, approaching, however, in appearance, some of the Lower Liassic or even Oolitic beds; but I must leave the matter in the hands of more experienced geologists.

## NOTICES OF MEMOIRS.

I.—Skuringsmærker og morænegrus eftervist i Finmarken fra en periode meget ældre end "istiden." Udgivet af Dr. Hans Reusch. (Med "An English Summary of the Contents.") Norges geol. undersögelses Aarbog for 1891, pp. 1–11.

Glacial-striæ and Boulder-clay in Finmark, belonging to a period much older than the "Ice Age." By Dr. Hans Reusch, Director of the Geological Survey of Norway.

THE northern shores of the interior of the Varangerfjord, at the far north of the Scandinavian Peninsula, consist of a low range of hills, mainly of sandstone and conglomerate, the beds of this latter rock reaching a thickness of 50 mètres. The conglomerate is entirely unstratified; it is composed of stones and small boulders, about the size of one's head, of Archæan gneiss, granite and diorite, with a slight admixture of fragments of dolomite and quartz, which are irregularly scattered in a ground-mass of reddish clayey sandstone. The general appearance of this rock so much resembled Boulder-clay that Dr. Reusch was induced to search the stones in it carefully, and he found definite well-marked scratches on some of the fragments of dolomite, whilst the surfaces of some of the pieces of harder rock were smooth and even, with traces of striæ. These markings were precisely similar in character to those produced by ice-action on the same kinds of rock in comparatively recent Boulder-clay, and could readily be distinguished from slickenside markings which were found to be present in the conglomerate as well. The evidence of ice-action was further shown by the presence of striæ and grooves on the surface of a hard sandstone immediately beneath the conglomerate, which had been laid bare by the weathering away of this latter. The striæ appeared to belong to two systems, and they could be traced up to and beneath the conglomerate.

The geological age of these ice-marked sandstones and conglomerates has not yet been satisfactorily determined; by Dr. Dahll they are considered as Permian, but Dr. Reusch thinks that they belong more probably to some portion of the Cambro-Silurian series, which prevails so extensively in Scandinavia; hitherto no traces of fossils have been found in them. If this view is correct, the discovery of what appears to be satisfactory and conclusive evidence of the presence of glacial action at this far distant period is a matter of considerable geological interest. In the paper Dr. Reusch gives figures of the scratched stones, with profiles and sketches of the rocks in which they occur. G. J. H.

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II.—Natural History Transactions of Northumberland, Durham, and Newcastle-upon-Tyne. Vol. X. Part II. (1890.)

TWO important contributions to the Geology of Northumberland and Durham, by Mr. Richard Howse, are comprised in the latest part of these Transactions. The first is a short paper on the South Durham Salt Borings, with remarks on the fossils found in the Magnesian-Limestone cores, and the geological position of the

salt. Mr. Howse attempts to prove the identity of the Upper Limestone in the salt-borings in South Durham with the Brotherton Beds in South Yorkshire, and the identity of both of these with the Plattendolomit of Germany. He also regards the lowest deposit of Rock Salt as of Permian age. The second contribution is a "Catalogue of the Local Fossils in the Museum of the Natural History Society of Newcastle-upon-Tyne," which occupies sixty pages, and was orginally issued as a separate publication at the time of the British Association Meeting in 1889. This is interspersed with numerous notes on stratigraphy, which are rendered invaluable by Mr. Howse's long experience in the detailed study of the district. The localities from which the specimens were obtained are mentioned under each species, and a reference is given to the record of its occurrence when already published.

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III. — Description des Syénites néphéliniques de Pouzac Hautes-Pyrénées) et de Montréal (Canada) et de leurs phénomènes de contact. By M. A. Lacroix. (Bull. Soc. géol. France (3), xiii. 1890, No. 7, pp. 511–58, pls. ix.–xii.)

THE many important contributions to our knowledge of the nepheline syenites made during the past few years by Brögger Tornebohm, Van Werwerke, Derby, and others, have received an important accession in the above Memoir by M. Lacroix. He here describes in detail the nepheline syenites of Pouzac and Montreal and their contact phenomena. At the former the rock is intrusive into a limestone, which is probably Cretaceous; the rock is of especial interest in connection with the alteration products. Thus the nepheline has given rise to (1) zeolites such as mesotype and hydronephelinite; (2) to white mica (gieseckite); (3) to garnets (of the ouwarowite type), which either replace the whole of the nepheline or are developed along the cleavage-planes; (4) to cancrinite; the amphibole (barkevicite) is altered to green mica, and the pyroxene is often surrounded by a zone of aegyrine. On the selvage the rock passes into a variety in which the magnetite, apatite, sphene, etc., and the ferromagnesian minerals (that is to say, those of the first two phases of the first stage of consolidation) are absent, and the sodic minerals (nepheline and sodalite) are replaced by a felspathic microlitic growth; the result is a rock comparable to the tinguaites of Prof. Rosenbusch, which in Brazil and Portugal are regarded as apophyses from nepheline syenite. Dipyre, actinolite, and pyrites occur in the limestone at the contact.

The nepheline syenite of Mont Royal, Montreal, pierces the Trenton limestone, and is itself of Silurian age. It is the principal member of a group of igneous rocks which includes some diabases, teschenites, and porphyrites. The diabases and teschenites both belong to a series resulting from the solidification of the same magma; the teschenites differ from the diabases in the presence of nepheline and sodalite; when olivine also occurs, the rock becomes one of the true teschenites (of Fouqué and Michel-Lévy) or theralites of Rosenbusch.

The normal porphyrites are probably microlitic forms of the diabase, just as the nephelinites with which the former are associated (occurring especially at the Mile End Quarries) are of the teschenites. At St. Anne there is a melilite of the same age as the other rocks of this group—a point of interest, as this variety has hitherto been regarded as confined to the Cainozoic.

The dominant type of the nepheline syenite is a rock with granitic structure and composed of grey or pink felspar, nepheline, sodalite, amphibole, pyroxene, and mica. The complete list of minerals numbers twenty-one, and these are all described in detail; the alteration products are similar to those of Pouzac. There are also some pegmatitic veins. Amongst the most important points in the memoir are those connected with the contact alteration of the rock: at places the normal structure is retained at the junction, but in other cases the rock is profoundly altered for a distance of some metres; the variations afford a complete transition from the granitic (grenu) to the trachytic types of structure, *i.e.* from the normal syenite to the "microsyenite"—a term he proposes owing to the analogy between this rock and the microgranites. The large dyke gives off small branches which traverse the limestone, and these are often composed of many alternating zones of the granitic and trachytic rocks. These dykes further lead to the mica porphyrites; the sodalite and nepheline are absent either owing to original poverty in soda, or to the greater influence of the endomorphic alterations on these thinner veins. The extent of the alteration of the limestone at the contact varies greatly; the minerals developed in the limestone are diopside, wollastonite, garnet, perowskite, and more rarely biotite, sphene, zircon, and felspars. The junction is sometimes marked by a band of cancrinite; but when the felspar is abundant, a zone occurs which may belong to either the eruptive or metamorphic rock.

The memoir is illustrated by twenty-six figures of rock-sections, while the great range in the variations of the rocks is further well brought out by the abundant use of M. Michel-Lévy's formulæ. M. Lacroix, it is interesting to note, rejects at the outset the use of the term elæolite syenite, and he lays special stress in his concluding paragraph on the identity in structure and mineralogical composition of rocks of Silurian age in Canada with those intrusive in the Cretaceous Limestone of the Pyrenees. J. W. G.

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IV.—Phenomena of the Glacial Epoch. Part II. The Great Submergence. By Dugald Bell. Trans. Geol. Soc. Glasgow, Vol. IX. pp. 100–138.

BY this Memoir the author has added another name to the growing list of papers written in opposition to the supposed glacial submergence of England and Wales to the depth of over 1300 feet. He summarizes all the evidence in favour of this view, and then subjects it to a careful examination, with the result of dismissing it as absolutely valueless. A submergence of 500 feet is admitted, but this the author attributes to the elevation of the sea-level by the attraction of the polar ice-cap heaping up the water in the northern latitudes. J. W. G.

## REVIEWS.

I.—The Naturalist of Cumbrae. A True Story: Being the Life of David Robertson. By the Rev. Thomas R. R. Stebbing, M.A. 8vo. pp. 398. (Kegan Paul, Trench, Trübner & Co., London, 1891.)

MR. ROBERTSON is well known to geologists through his researches on the Ostracoda and Foraminifera of the later Tertiary or Quaternary deposits; and in these studies he has been associated with Dr. G. S. Brady and the Rev. H. W. Crosskey. The living forms of these minute organisms have likewise engaged much of his attention, and in the course of dredging investigations over a wide area around the British Isles, he has added largely to our knowledge of Marine Zoology and Botany. A very pleasant story of his life is given by Mr. Stebbing in the volume before us, and although Mr. Robertson is still enjoying the fruits of a well-spent life, yet being in his 85th year, his work is practically accomplished, and no apology is needed for the publication of the book.

Born in a humble sphere of life, and losing his father when quite an infant, David Robertson was supported in early years by the labours of his mother, and under these circumstances he received but a year's regular schooling between the ages of 7 and 8. Then he gained employment on a farm in Lanarkshire, and for some years, under different masters, he was engaged chiefly in agricultural work, obtaining an occasional change for short intervals in quarry-work and in the weaving-trade. Thus was he occupied until he reached the age of 24, without having made any position for himself, although all along he was desirous of bettering his circumstances. He gained what education he could by attending night-classes and by the loan of books, whenever any were to be had; and it is noteworthy that the Travels of Mungo Park and the Natural History books of Buffon and Goldsmith thus came into his hands. Two of Robertson's old playmates had now entered the College at Glasgow, as Divinity students, and, remarkable as it seems, he was fired with the ambition to become a Medical student. His friends naturally enough tried to dissuade him; but he obtained an interview with the Anatomical Professor, and received the encouraging assurance that by industry he might accomplish his desires. He resolved to enter the College, and gaining employment with a dyer, whereby he was enabled to support himself in a frugal way, he pursued his studies with zeal. During the next few years (1831-34) he duly attended the College courses, and gained the needful certificates. He subsequently learned Dispensing at a shop in Glasgow, and obtained some practical experience in Medicine and Surgery at the Infirmary.

Now, however, at the age of 30, when ready to go up for examination, circumstances entirely altered his career. He became enamoured of the daughter of the dyer, a maiden who had charge of a crockery-business that belonged to her father. There was the opportunity for Robertson to take charge of a similar business, and it set him meditating on his prospects. He wisely came to the con-

clusion that business offered him better chances of making an income than the work of a doctor. His friends, as well as the College authorities, now urged him to proceed with his medical work; but he had made up his mind. He married and set up in business, with seven pounds in hand to furnish his house and stock his shop. Right well he and his wife succeeded, so that the business steadily increased. He made journeys to the Potteries and to Hamburgh so as to buy direct from the manufacturers, and by dint of hard work succeeded by the year 1860 in accumulating a sufficient fortune to retire in comfort.

As early as 1837, however, Mr. Robertson began his natural history studies. "Between the years 1850 and 1860 natural history pursuits and business occupations overlapped one another, but the true naturalist 'has no time for money-making,' and accordingly the time came when science extinguished commerce."

He then obtained a house known as Fern Bank, at Millport in Great Cumbrae, an island in the Firth of Clyde. To this island he had frequently gone for relaxation in previous years, and although he continued to reside for some years principally at Glasgow, yet since 1886 the little island has been the permanent home of the Naturalist.

Rather more than half the volume is devoted to an account of Mr. Robertson's scientific labours, of his dredging explorations, and of the Naturalists with whom he became associated; amongst whom Dr. Harvey, Dr. Baird, the Rev. A. M. Norman, Dr. Gwyn Jeffreys, Dr. Dohrn, and others. There are reminiscences of Thomas Edward, whose history, as Mr. Stebbing remarks, tends "to cast something of a sombre gloom over scientific pursuits." He adds, "It is well that it should be seen that there is no necessary connexion between an intense love of nature and a deplorable condition of a man's private affairs." Mr. Robertson, however, was evidently too much of a business man to neglect trade in the pursuit of his hobbies, and after successfully fighting the battle of life, he has done excellent service in the cause of science. H. B. W.

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II.—The Perisomic Plates of the Crinoids. By Charles Wachsmuth and Frank Springer. Proc. Acad. Nat. Sci. Philadelphia, 1890, Part III. pp. 345–392, Pls. IX. X. (February, 1891).

THIS paper, although in the importance of the facts which it makes known it can hardly rank with the same authors' recent paper on the ventral structure of *Taxocrinus* and *Haplocrinus*,[1] will nevertheless mark an important advance in the history of Crinoid Morphology.

The authors divide the skeletal elements of a Crinoid into *primary* and *secondary*. *Primary* elements include (*a*) the Abactinal plates, developed on the right antimere and connected with the axial nerve-cords, viz. stem-ossicles, infrabasals, basals, radials, and all

[1] "Discovery of the ventral structure of *Taxocrinus* and *Haplocrinus*, and consequent modifications in the classification of the Crinoidea," Proc. Acad. Nat. Sci. Philadelphia, 1888, part iii. pp. 337–363, pl. xviii. (February, 1889).

brachials, and (*b*) the Actinal plates, developed on the left antimere and connected with the mouth, viz. orals and all plates of the ambulacra. The *secondary* or *supplementary* elements are all the interradial, interbrachial and interambulacral plates, including the anal plates and plates of the tube or sac. These apparently are what they call "perisomic," although the term would seem legitimately applicable only to plates that, one way or another, form part of the calyx.

The title, however, in no way does justice to the contents of the paper. For the authors discuss the homologies first of the plates of the ventral surface generally, secondly of the anal plates; and as side-issues, but important ones, they treat of the interradial plates and of the large plates, hitherto called interradials, seen in the tegmen of the Cyathocrinidæ.

Those who have regarded the question in a purely morphological aspect have long doubted the existence, at least in many cases, of a "*vault*," by which was meant that outer roof of plates supposed, in the Camerata, to conceal another integument, often plated, homologous with the so-called "disk" of an *Antedon*. Thus Dr. P. H. Carpenter in his "Challenger" Report on the Stalked Crinoids (1884), although he still allowed a "vault" to the Actinocrinidæ, could not accept it for the Reteocrinidæ, Ichthyocrinidæ, and most of the Platycrinidæ. The admission of Messrs. Wachsmuth and Springer (Revision III.) that the calyx interradials were continuous with those of the "vault" seemed inconsistent with the presence of other interradials in a supposed "disk" beneath the "vault"; the growth of plates outward and downward from the orals and upward from the interradials, through regions where no connective tissue previously existed, the two meeting in air like a cantilever bridge, was incomprehensible; while the grave statement that the plates of such a "vault" corresponded one for one with the plates of the underlying "disk" (Revision III. 60) showed the untenability of the whole hypothesis. There were—as there are still—certain difficulties in any other explanation; but the paper of Messrs. Wachsmuth and Springer on *Taxocrinus*, etc., furnished so complete a set of links between the "disk" and the "vault" that doubt was no longer possible, and in April, 1890, the present writer denied the existence of any structure covering the disk, and proposed in all cases to use the word *tegmen* (Ann. Mag. Nat. Hist. [6] v. p. 313).

Messrs. Wachsmuth and Springer have now confirmed this conclusion by finding satisfactory homologies for the plates of the tegmen in Actinocrinidæ. The simplest form of tegmen in Crinoids consists of only five plates, interradially disposed, that meet over the mouth and are called *orals*: this is now regarded as also the earliest form. It is supposed that, to increase the calycal cavity, *interradial* plates were developed between the radials, while similar *interambulacral* plates, as well as extensions of the *ambulacral* plates, gradually intervened between orals and radials. The orals might disappear or remain. As the lower parts of the arms became incorporated in the dorsal cup, more and more ambulacral and inter-

ambulacral plates naturally came into the tegmen. The plates of the tegmen were at first small and yielding, as in the Ichthyocrinidæ and in most recent Crinoids; in this state when the arms are open the ventral surface is depressed, when they are closed it bulges upwards. To afford better protection to the viscera the tegminal plates became more solid; the tegmen being thus less flexible was fixed perforce in its protruded state. The *covering-plates* of the ambulacra had perhaps been closed from the beginning, but as, through the upswelling of the tegmen, they were now more exposed, further protection was needed. Consequently they were lowered beneath the surface and, starting from the solid orals, interambulacral plates closed in over them. Certain of the covering-plates however, especially, it would appear, the axillary pieces, which perhaps could not so easily be covered by other plates, became much stouter and were still exposed on the surface as solid *radial dome plates*. In any form highly developed along these lines, *e.g. Batocrinus*, the food-grooves, water-vessels and blood-vessels are sunk right beneath the tegmen and are enclosed in a tube consisting of alternating ambulacral or covering plates above and adambulacral or side plates below. The interambulacral plates of the tegmen send curious extensions into the interior of the calyx, and these extensions, spreading out, form what was formerly supposed to be a disk. We may, with Messrs. Wachsmuth and Springer, regard the extensions as caused by the perforation of the plates for water-canals; or we may regard them as simple processes for the purpose of adding strength, without forgoing lightness, by a system of girders.

In the Inadunata Fistulata the dorsal cup never extended beyond the radials, and the tegmen was not developed to the same extent as in the Camerata. The orals did not, however, always persist in the simple stage in which they occur in the Larviformia; in many cases they were, in the opinion of the authors, entirely resorbed, while their places were taken "by large covering plates, of which the proximal ones joined in the center." Ambulacral and sometimes a small number of interambulacral plates occur in the tegmen of the Cyathocrinidæ; besides there are four large plates, one in each interradius except the posterior, which rest against the radials, meet laterally beneath the ambulacra, and may be covered to a varying extent by small interambulacral plates. In the posterior interradius there lies, between the ventral sac and the mouth, a plate often very similar in shape and position to these four. This plate is stated by our authors to be "profusely perforated" in various Lower Carboniferous Cyathocrinidæ, and they state that on either side of it lies a small narrow plate which meets the large plate of the adjacent interradius beneath the ambulacrum. These two narrow plates are quite new discoveries. Once upon a time the five large plates were considered to be orals, a view subsequently abandoned by Wachsmuth and Springer and P. H. Carpenter owing to the passage of the ambulacra *over* and not between the edges of the plates. Wachsmuth and Springer have since then regarded them as interradials; this view they now drop because the plates "support the ambulacra and

are covered by perisome," and because in the posterior interradius they do not rest on the special anal plate. They now believe that "the perforated plate is a true anambulacral plate, analogous with the perforated limestone particles at the disk of recent Crinoids," and that the two narrow plates and "possibly also the four larger ones, wholly or in part, are subambulacral plates."

This view is absolutely new and, if proved, of great importance; its adequate discussion is beyond the limits of a review, but we cannot refrain from a few remarks. What do the authors mean by "subambulacral plates"? The term was proposed by Joh. Müller in 1854 for a series of median plates lying beneath the food-groove of *Pentacrinus asteria*, and therefore radial in position like the lancet-plates of the Blastoids. But the plates now under discussion are interradial in position, and only their edges are immediately beneath the food-groove. This difficulty must have been seen by the authors themselves, for they say: "*interradial* plates, as the term denotes, cannot be *subambulacral*." It is hard to see how they better their position by the suggestion that these plates are homologous with the deltoids of Blastoidea, and that they each consist of a median interradial plate fused with two lateral plates that underlie the ambulacra. Not only is this, as they admit, unsubstantiated hypothesis, but if proven, while it would leave an interradial portion still to be accounted for, would not make the lateral portions one whit the more subambulacral, although they might then be considered as adambulacral.

We do not here wish to maintain that the plates are orals, but the authors hardly seem to have given good reasons for the rejection of that view. How do they know that ambulacra cannot pass over the edges of orals? The change may have taken place gradually, and is no more impossible than the sinking of ambulacra. They must show both orals and these interradial plates coexisting in some particular specimen; and this they do appear to state on p. 357: "That the plates are not orals is further proved by the fact that there are in *Cyathocrinus iowensis* other large plates covering the peristome, which naturally represent them." But they do not say how they distinguish the partly resorbed orals from the large covering plates that, in the same specimen (pl. x. fig. 3), are stated to join in the centre.

Then again the plates are stated not to be interradials, because they are covered by perisome; but have the authors ever seen a specimen in which these plates existed but were *entirely* hidden by interambulacral plates? If so, it would have been well to have definitely stated as much; and even then, why should not an interradial plate sink below others until it is covered by them?

Some argument, which we do not follow, is based on the "perforated" plate or "madreporite." Now this plate has been known for some time, and presents all stages of folding, rugosity, and pitting, but that the pits represent pores rests on the statement of these authors. It is a pity that, with their abundant material, they did not cut a single section so as to prove the point. This

plate is present in *Euspirocrinus spiralis*, though they speak as if it were absent; on the other hand they state that the ventral tube of that species is "profusely perforated." Now in 1879 they said of it, "Pores have not been observed" (Revision I. p. 143); their present drawings show no pores; in the type-specimens pores are not evident. On what grounds then are we to accept this assertion?

Here we may also note an account of the anus in the Cyathocrinidæ differing from any previously given; and a repetition of their former statement as to its position in the Poteriocrinidæ; but of proof or illustrations never a scrap. Messrs. Wachsmuth and Springer should remember that, in scientific treatises at all events, neither inspiration nor authority can supply the place of evidence and argument.

The latter half of the paper deals with the anal plates. These are not regarded as homologous with the interradials, but are more supplementary still, being "introduced as the case required." They are also distinguished from the plates of the ventral sac or anal tube, a difference of terminology that occasionally seems to make the authors think that there is also some difference in morphology. However, since this idea materially simplifies all discussion as to homology and at once puts some recent speculations out of court, one cannot blame the authors for adopting it. It should, however, be noted that to regard the special anal plate of the Fistulata as a purely supplementary piece, and to suppose that the additional anal plate in such forms as *Poteriocrinus* is a fresh introduction, are ideas wholly different to any previously advocated by these writers. They have also considerably changed their views with regard to *Baerocrinus*. Much of this half of the paper is however unavoidably controversial, and will be more fittingly discussed in another place.

The first half of the paper is also controversial in tone, although, since their own errors were the greater, the authors might well have left Dr. P. H. Carpenter alone. They have, we suppose, got so accustomed to sparring with him that they like to keep it up if only for exercise. This however hardly excuses the gloveless way in which they handle him; while their occasional distortions of his words are rather like hits below the belt. Thus on p. 350 they say: "The ventral pavement of an *Actinocrinus* he calls 'a structure sui generis,' *i.e.* different from that of a *Platycrinus*." Dr. Carpenter's words (Chall. Rep. Stalked Crin. p. 157) are these: "The solid vault of an *Actinocrinus* is a structure *sui generis*, unless, as I believe, its proximal ring of interradial plates is represented by the orals of a Neocrinoid," *i.e.* it is *not* a structure *sui generis*; and Carpenter's homology of the proximal interradials is the very one now adopted by his critics! Again (*op. cit.* p. 178) Dr. Carpenter says: "The peripheral portion of the vault of *Platycrinus*, *i.e.* the zone between the proximal dome plates in the centre and the calyx interradials, is comparatively small; and its interradial spaces are 'occupied by three—rarely five—plates . . . resting upon the interradial of the calyx.' This series of four or six interradials, taken all together, . . . corresponds generally to the single large interradial of *Cyathocrinus*

. . . [*i.e.*] all belong to the same system of interradial plates. . . . Wachsmuth says that 'the first interradial [of the Platycrinidæ] is identical with the outer interradial plate of *Coccocrinus*,' in which I entirely agree." Now see how these plain words are transmogrified on p. 351 of the present paper:—"He regards (p. 178) the peripheral portion of the 'vault,' by which he means the zone between the so-called summit plates and the radials, as generally corresponding to the large interradial of *Cyathocrinus*, and to the single interradial of *Coccocrinus*." We draw particular attention to these misrepresentations, not because we suppose for a moment that they are intentional, but in order that readers of Messrs. Wachsmuth and Springer may not trust too lightly either to their citations or to the charges of misrepresentation that they bring against others.

We think indeed that what was correct in the writings of Dr. Carpenter, not to mention others, might have been more graciously acknowledged; and we would distinctly reprehend the omission of all allusion to Dr. M. Neumayr's explanation of the vault in the Camerata, which appeared in Die Stämme des Thierreiches (1889), and was substantially the same as that now put forward by Messrs. Wachsmuth and Springer. Much, however, may be pardoned in consideration of the extreme interest of the present paper, which, while it knocks the final nail into the coffin of the "Palæocrinoidea," gives promise of many a vigorous discussion in the near future.

The exquisite illustrations to this paper are by two well-known Swedish artists. To the accuracy of the drawings by Mr. G. Liljevall the present writer can bear witness; of their beauty there can be no question. Those by Mr. A. M. Westergren are no doubt equally accurate, but the touch is a little too delicate; plate x. should have been printed in darker ink. Pl. ix. fig. 1, *Cyathocrinus alutaceus*, Angelin, must be referred to *C. ramosus*; fig. 2, *C. lævis*, Ang., is also a *C. ramosus*; fig. 3, *C. lævis*, Ang., belongs to an undescribed species. It is important to note that the originals of figs. 2 and 3 are abnormal in the cup. These changes make no difference to the argument of Messrs. Wachsmuth and Springer; but the references to the figures (p. 356) might be corrected with advantage, the numbers 2 and 3 are interchanged, which is perplexing. Plate x. fig. 15, is not alluded to either in the text or in the explanation of the plate. But our most serious criticism of the drawings is, as said before—*there are not enough.* F. A. B.

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III.—Contributions à la Géologie des Pays-Bas—V. Les Dunes intérieures, les Tourbières basses et les Oscillations du Sol. Par Dr. J. Lorié, Archives Teyler, Sér. II. Tome III. 5e partie. (Haarlem.)

THE Memoir which forms the subject of this notice is the fifth of a series which we owe to the industry of Dr. J. Loiré of Utrecht. It brings the geological record of Holland down to the period of authentic history, in fact, to the present day. In his previously published works the author has brought together an

enormous amount of evidence bearing on the question of the later Tertiary earth-movements in Holland. He has shown that there has been extensive, though perhaps intermittent, subsidence in this area during the Pliocene and Pleistocene period; he now attempts to demonstrate that this movement has continued, intermittently and irregularly, since the period of the Roman occupation, and probably down to the present day.

The most interesting part of this Memoir to the English reader probably will be that treating of the changes of the level which have taken place since the Roman period; for though much of the evidence has long been published, it has been so scattered that one is now startled to find what a strong case can be made out for the continuity of the movements of subsidence. Of course Dr. Lorié takes into account the subsidence caused by the slow compression of the peats and clays, as the organic matter decays and the water is squeezed out. But making every allowance for this, there still remains, according to Dr. Lorié, a considerable amount of subsidence unaccounted for. It may be well, however, to point out that no one case of Post-Roman subsidence in Holland appears to be conclusively proved; for the absence of any solid foundations for either ancient or modern buildings leaves it open for any one to suggest bad foundations as the cause of the present low position of the remains. It is the cumulative force of the evidence, all pointing in one direction, that makes the case so strong, especially when the Pliocene and Pleistocene subsidence to the extent of at least 1100 feet is taken into account.

Among the Roman remains found in Holland below the sea-level, the fortress of Brittenburg ("Arx Brittaniæ") was perhaps the most interesting. The ruins were visible at exceptionally low tides during the sixteenth, seventeenth and eighteenth centuries, but have now been entirely destroyed. They showed, according to Dr. Lorié, a sinking of at least three metres since the third century. Another ruin—the temple of Nehalennia in Zealand—was considered by Laveleye to have subsided six or seven metres since it was built. When last seen the floor was at the level of low water, and Laveleye concluded that originally it must have been above the level of the highest tides.

Oaken planks of prehistoric date have been found beneath the peat at a depth of thirteen feet below mean tide, and traces of an inhabited land surface with egg-shells and cut wood at sixteen feet below the surface. By these one is reminded of the traces of a fire found in a submerged forest at low-water level in some excavations for docks at Hull. Belonging to a still older period we find abundance of submerged forests and peat mosses at depths ranging to fifty feet or more below the sea. Much of the remainder of the Memoir is devoted to minute measurements of the amount of subsidence which has taken place since the date of the first accurate surveys. Other portions deal with the origin of the inland sand-dunes, and with the peat mosses. C. R.

IV.—The Geology of the Country Around Liverpool, including the North of Flintshire. By G. H. Morton, F.G.S., etc. Second Edition. Pp. 287. (George Philip and Son, London, 1891.)

NEARLY eight-and-twenty years have elapsed since the former edition of this work was published. During the interval Mr. Morton has laboured with great enthusiasm and with much patience at the rocks that lie within a distance of about twenty miles from Liverpool. He now gives a particular account of the Carboniferous rocks, to our knowledge of which, and especially of the Carboniferous Limestone of Flintshire, he has largely added. This Limestone is probably the most attractive formation within easy reach of Liverpool, and the palæontology of its several subdivisions has been carefully worked out by Mr. Morton. The Cefn-y-Fedw Sandstone overlies the Carboniferous Limestone, and probably represents the Yoredale Series and Millstone Grit of other districts. These beds and their subdivisions, together with the overlying Coal-measures of North Wales and South-west Lancashire, are duly described. Permian beds occur in some localities near Liverpool; but over much of the area to which reference is made, where the strata are known only from the evidence obtained by shafts and borings, there is a considerable difficulty in distinguishing between Permian and Bunter.

The Bunter Beds, having a thickness of nearly 2000 feet, comprise Lower and Upper Soft Sandstones, with intermediate Pebble-beds. Mr. Morton in describing the Pebble-beds finds it convenient to divide them locally into a lower division with numerous pebbles and an upper division, with few or no pebbles. The Keuper Sandstone and Marl succeed. The Sandstone is of especial interest on account of the "Footprint bed" that occurs (about 124 feet from the base of this division) in the Storeton quarries. Among the tracks are those named *Cheirotherium Storetonense* by Mr. Morton, and they are illustrated in a series of plates. The name of this familiar genus is now unfortunately changed, and the animal is designated *Chirosaurus Storetonensis* (Lydekker, Cat. Foss. Rept. and Amphib. Brit. Mus. Part iv. 1890, p. 216). Footprints of *Rhynchosaurus* are also described and figured.

Some space is devoted to the microscopic characters of the rocks, and to Faults and Denudation; and a number of longitudinal sections are described. Then follow accounts of the building-stones and other economic products, a list of minerals, and remarks on the subject of Water-supply. Some of these matters might better have been treated at the end of the volume, for the author now proceeds to describe the Pleistocene deposits. Among the more interesting of these deposits are those found in the Caves of Ffynnon Beuno and Cae-gwyn that contains relics of "Pre-glacial" Mammalia, or more strictly speaking of forms older than the Boulder Clay of the neighbourhood. Mr. Morton quite agrees with Dr. Hicks in regarding the Mammalia as older than the Glacial Drift, and believes that all the objections raised in opposition to this view have been

answered. The Glacial deposits and the Glacial striæ are fully described, as well as the Post-Glacial Peat and Forest-beds, and other Recent deposits; and the author concludes with some brief remarks on the Origin of the Mersey.

The labours of other geologists have received attention, references being made more especially to the papers by Prof. Hull, Dr. Ricketts, Mr. Mellard Reade, Mr. C. E. De Rance, and Mr. A. Strahan. No reference, however, is made to Mr. Mellard Reade's paper on the Physiography of the Lower Trias (GEOL. MAG. 1889, p. 549); possibly his views on this subject were considered too heterodox to be mentioned. The author, moreover, has received special help in some instances, Mr. R. Kidston having furnished a valuable list of fossil plants from the Coal-measures of Ravenhead, near St. Helens; and Mr. J. G. Goodchild having contributed notes on some of the rocks found in the Glacial Drifts. Combining as it does the results of long-continued personal observation, Mr. Morton's book furnishes an authoritative guide to the student, and will be of essential service to all geologists who seek acquaintance with the geology of the country around Liverpool. H. B. W.

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V.—THE TRIASSIC ROCKS OF WEST SOMERSET, AND THE DEVONIAN ROCKS ON THEIR BORDERS. By W. A. E. USSHER. Proc. Somerset Arch. and Nat. Hist. Soc. Vol. XXXV. for 1889. (1890.)

IN this paper Mr. Ussher sums up the results of his observations on the Devonian rocks of the Quantock and Brendon Hills, and of the neighbourhood of Porlock and Minehead; and he gives his latest views on the Triassic rocks that border these old rocks near Stogumber, Williton, and Porlock. The sandstones, breccias, conglomerates and marls of the New Red Sandstone series, are all grouped with the Trias; but some changes have been made by Mr. Ussher in his grouping of beds at particular localities. Thus he now recognizes no divisions older than the Keuper, among the New Red rocks west of Williton, and believes that the coarser beds of the Keuper were accumulated higher and higher in the series in that region, progressive subsidence having led to the continuation of marginal deposition.

With regard to the Devonian rocks, Mr. Ussher publishes a table to show their general classification, and the correlation of the subdivisions in North and South Devon with those of Germany, France, and Belgium. In West Somerset and North Devon there is a much greater development of sandstones than in South Devon, for the Cockington Sandstones of the Torquay district, at one time regarded as Upper Devonian, are now placed (together with the Lincombe and Warberry Grits) on the horizon of the Hangman Grits of North Devon. It has been suggested that in North Devon the Foreland Grits and Hangman Grits, which are of similar general character, are the same. Mr. Ussher shows by diagram that this may possibly be the case: but he gives various reasons, sufficient, in his opinion, to negative the supposition that they are identical. The Pickwell Down Sandstones, that were at one time grouped with

the Cockington Sandstones, are now placed alongside the Chudleigh Limestone and the Frasnian Beds. The Morte Slates are left in a doubtful position between Upper and Middle Devonian.

The facts brought forward have reference mainly to the distribution of the several divisions and to the faults and flexures to which they have been subjected; and they are illustrated by an excellent coloured geological map.

The author gives an interesting account of his discoveries of fossils in the Lower Devonian rocks of South Devon, and hopes that geologists will be stirred up to look for organic remains in the great Grit-beds of North Devon. The Hangman Grits have yielded *Natica* and *Myalina*: in the Foreland Grits no fossils have yet been detected. The Morte Slates, regarded as unfossiliferous, have since yielded a *Lingula* to Dr. Hicks, so that there is hope for those who will have the patience to spend hours on rocks that are apparently barren, instead of devoting their energies to more tempting strata that are known to be fossiliferous. H. B. W.

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VI.—Report of Exploration of the Glacial Lake Agassiz in Manitoba. By Warren Upham. Ann. Rept. Geol. and Nat. Hist. Surv. Canada, Vol. IV. Part E. Pp. 156, 2 Maps, and Plate of Sections. (Montreal, 1890.)

THE suggestion by the late Prof. J. Carvill Lewis that the Boulder-clay of our Eastern counties was formed in a great glacier lake reminded English geologists of the wide extension of such deposits in America. The theory was not a new one in English geology, as it had been used by Agassiz in 1842 to explain the origin of the Parallel Roads of Glen Roy, and has been applied quite recently by Goodchild to the high-level drifts of the Thames Estuary. Mr. Warren Upham, in the above Memoir, has now worked out in detail the evidence for the former existence of a glacier lake in Minnesota and Manitoba compared with which our own sink into insignificance. General Warren, in 1867, discovered that Lake Winnipeg once had a southern outlet, due, he considered, to an alteration in the contour of the country; this view was accepted by Dr. G. M. Dawson and Prof. Dana. Prof. Winchell, however, in 1877, attributed it to the accumulation of water in front of the northern ice-sheet, and two years later Mr. Warren Upham advocated the same theory, and suggested the name of "Lake Agassiz." According to this view, by the recession of the ice-sheet, a number of rivers were enabled to return to their original northerly direction, but as their waters were dammed back by the ice, a series of lakes were formed, the largest being Lake Agassiz. At first the only outlet of this lake was down the Minnesota River to the south, this being the lowest point on the watershed, but as the glacier receded still further to the north, a series of outlets to Hudson Bay were gradually opened. Five beaches were deposited during the former period, and eleven during the latter. The deposits of the lake now cover 110,000 square miles, so that it was larger than the combined areas of the five Laurentian lakes; but it never reached this size at any one time; when the highest beaches of the southern

part were being deposited, the northern part was still covered by the ice, and before this district was submerged the opening of the northern outlets had so lowered the water-level that the southern shore had followed the ice to the north. With the final disappearance of the ice-sheet, Lake Agassiz was reduced to a series of scattered lakes, of which Lake Winnipeg is the largest.

The ordinary Glacial drifts of the district are attributed to the action of land-ice, as there is no sign of any transport in or assortment by water. The maximum thickness is 250 feet; the lower part is very hard and tough, but the upper beds are fairly loose and can be dug. The author attributes the difference to the former having been subjected to the enormous pressure of the weight of the ice-sheet, while the latter was merely dropped during the melting of ice. There are many boulders mainly of the Archæan rocks from the N. and N.E.; the largest is 22 ft. by 8 ft. by 14 ft. Striæ are well preserved and their directions are given in an appendix. The more especially lacustrine deposits include a series of sixteen beaches; these are from 25 to 30 rods in width, and rise from 3 feet to 10 feet on the shore side, and from 10 feet to 20 feet on the lake side. There are also a number of deltas and kames and osars: the author uses the two last terms as defined by McGee and Chamberlin; he applies "osars" to the drifts formed in the river-courses, and "kames" to the irregular deposits dropped where the rivers have emerged from between their ice-walled channels and spread out over the adjoining lowlands.

A few freshwater Mollusca of existing species have been found, and some worked flints indicate that man lived on the shores of the lake before the opening of the northern outlets. But the author, quoting a long series of independent estimates, considers that this was less than 10,000 years ago.

It is found that the beaches ascend as they are traced to the North, the amount varying from one to sixteen inches to the mile: he concludes—accepting Mr. R. S. Woodward's calculations—that a quarter of this was due to the heaping-up of the water by the attraction of the northern ice-sheet. After a careful consideration of Chamberlin's hypothesis of alterations of level being due to contraction of the earth's crust consequent on the lowering of the isogeotherms by a glacial climate, it is rejected as inadequate, as its influence would be the reverse of that which has taken place in the Lake Agassiz area.

The memoir closes with a chapter on the "Geologic and Agricultural Resources" of the district. It is illustrated by a couple of maps and a plate of sections; but further illustrations will no doubt be given with the more detailed description to be given by the author in one of the Monographs of the United States Geological Survey. The exploration, it should be added, was undertaken, on behalf of the Geological Surveys of the United States and Canada, both of which may be congratulated upon an arrangement whereby, in defiance of International Boundaries, the whole work was entrusted to one man, and also upon having secured the services of a geologist whom a long training in glacial geology had rendered especially competent for the task. J. W. G.

VII.—Aids in Practical Geology. By Prof. Grenville A. J. Cole, F.G.S. 8vo. pp. 402. (London, Charles Griffin & Co., 1891.)

PROFESSOR Grenville Cole's "Aids" is a work occupying an unique position in geological literature. Every one trained in the modern school of Geology has a vivid recollection of the numberless sources from which he was compelled to select the various necessary items of information. Apart from ordinary geological text-books, there were works on chemical analysis, qualitative and quantitative, on blowpipe analysis, mineralogy, and general physics, technical treatises and memoirs on the microscopical examination of rocks, and various other less important references too numerous to mention. He was continually dependent upon the Professor for advice and help; and he was led most emphatically to realize the extraordinary combination of scientific methods that is requisite for the satisfactory study of a geological formation. The new volume before us dispels all these difficulties, and now, for the first time, renders it possible even for an ordinary amateur to gain an adequate knowledge of the subject up to date. Not only is this the case, but many of the open paths for further investigation are incidentally pointed out, with sufficient references to original memoirs to enable an enthusiastic student to proceed far in this direction.

Prof. Cole is throughout eminently practical. Several guides to the beginner in Field Geology have already appeared, but we have never met with so concise a series of useful hints as to small matters that most geologists have to learn by experience, as can be found in the first part of the present work. Not only is the equipment discussed in a manner that betokens wide experience, but the most precise information is afforded as to the best form of gymnastics for various difficult circumstances, such as the crossing of streams and the scaling of crags. In the remarks on packing specimens, again, even such minutiæ as the peculiar Parcel Post regulations of Italy are briefly noticed; and in this section of the book, as in the others, scarcely an instrument is mentioned without some allusion to its cost, its comparative efficiency, and the name of the maker from whom it can be obtained. In many instances, directions are given for the construction of simple apparatus from common materials, such as gallipots, corks, and wire; and the circumstances of travellers in regions distant from ordinary civilization are always carefully remembered.

The second part of the book is devoted to the examination of minerals, forming not merely a concise statement of the ordinary methods of determinative mineralogy and an index to the characters of the species of most common occurrence, but also comprising numerous hints and cautions which the student will soon learn to appreciate. Two conspicuous features are the elaborate treatment of the determination of specific gravities, and an interesting chapter on Szabó's method of quantitative flame-reactions for the felspars and their allies. After these preliminaries, the most important part of the work, relating to the examination of rocks, immediately follows. Rock-structures are first treated in a general way, the principal

characters and varieties of several groups—the coarsely fragmental, ordinary stratified, cleaved, foliated, and igneous—being successively pointed out. The determination of the specific gravity, fusibility, and chemical composition of rocks, is next considered; and an important chapter on the isolation of the constituents of rocks is followed by a short and practical discussion of the petrological microscope and the preparation of rock-sections. With the chapter on the more prominent characters to be observed in minerals in rock-sections, and the following synoptical remarks on the appearance of thin sections of the chief rock-forming minerals, the student enters upon a subject that requires long practice for its adequate comprehension; but Prof. Cole's "aids" are among the most valuable that have hitherto appeared, including, indeed, some items that have scarcely yet reached ordinary handbooks, and numerous notes in special type when there is any possibility of doubt or misinterpretation. The sedimentary rocks, as usual, occupy a comparatively small amount of space, but all the latest discoveries relating to them seem to be duly incorporated in the synopsis. The igneous rocks are treated with remarkable elaboration, and students will be grateful to the author for presenting so concise a summary of the main facts with a comparatively simple nomenclature. As Prof. Cole remarks, "petrography has of late suffered from the introduction of an abundance of new terms, and, what is far worse, of old terms defined in new senses; but the majority of these can be avoided by the use of familiar adjectives or mineral prefixes, to the great lightening of the science." The Holocrystalline Igneous Rocks are subdivided into the six groups of Granite (with Eurite), Syenite, Quartz-Diorite (with Quartz-Aphanite), Diorite (with Aphanite), Olivine-Gabbro (with Olivine-Dolerite), and Peridotite. The Lithoidal Igneous Rocks, with some glassy matter, are classified as Rhyolites, Trachytes, Rhyolitic Andesites, Andesites, Olivine-Basalts, Limburgites, and Hemicrystalline Nephelinites (with Leucitites). The Highly Glassy Rocks comprise the Obsidian and Tachylyte Groups. In the case of every term, a reference to its original definition is given, with frequent notes upon subsequent changes in its meaning; and a table is added exhibiting the relationships of the various types, so far as determined.

The chapter on Metamorphic Rocks is characterized by much caution in alluding to theoretical matters, and the definition of the limits within which the term "metamorphic" is applicable is well stated to be a "matter of opinion." Prof. Cole places in this category all rocks in which new crystalline developments, or new structures, or both, have arisen under the influence of subterranean heat, or pressure, or actual earth-movement. He seems, moreover, to show more sympathy with the original views of "regional metamorphism," than with the recent speculations of those who regard the Archæan rocks as unique among geological formations. In referring to the so-called "true schists," for example, he remarks "that the alleged distinction between schist-like rocks and schists of Pre-Cambrian age requires such great delicacy of definition that

the majority of observers must be content to use the word 'schist' in its wide practical signification, covering all well-foliated rocks, of whatever age, which fall short of the coarser and more felspathic type styled gneiss."

The final section of the work is devoted to the examination of those fossils which are of especial value for stratigraphical purposes. The Invertebrata alone are treated, and an attempt is made to define in scientific terms each of the more conspicuous genera, often with an illustrative woodcut. This plan is a great improvement upon the time-honoured custom of recording lists of names of fossils with merely incidental allusions to their characters, of which occasional figures are supposed to give an adequate conception. The subject, however, is so vast that we doubt whether Prof. Cole's brief outlines will in many cases suffice for the requirements of an ordinary worker in unknown regions, and we trust that some day the scheme may be further elaborated.

It is difficult to criticize a work of this nature; every specialist will hold his own opinion with regard to the particular section that concerns his own line of research. We are inclined to think, however, that in some instances simple matters might have received more attention. In certain strata, for example, a sufficiently accurate determination of the true dip can readily be made by employing a spirit level to ascertain the line of strike and fixing the clinometer at right angles to this, without any of the geometrical constructions such as Prof. Cole alone describes. But we have most serious fault to find with the publishers. In a work so admirable both in subject-matter and typography, the coarseness and inartistic character of so large a proportion of the new figures is a blemish of which it is impossible to speak too harshly. In this respect, it forms a striking contrast to the scientific handbooks issued by publishers abroad, and we trust that in the next edition the fault may be entirely remedied. That such an opportunity will soon present itself we are fully assured, for the volume is one that will prove invaluable and be welcomed by all students of Geology.

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VIII.—The Geology of Barbados. By J. B. Harrison and A. J. Jukes-Browne. 8vo. pp. 64 and Map. (Published Barbadoes? 1890.)

SO long as it is argued that the Glacial period in England was due to the diversion of the Gulf Stream will geologists feel interested in all investigations upon the later Tertiary geology of the West Indies. The island of Barbados moreover, possesses an additional source of interest in the Radiolarian deposits so long noted for the beauty of their fossils, and now of especial value from their bearing on the question of the permanence of oceans and continents. We must, therefore, feel much gratitude to the authors of this memoir for the care with which they have worked out the geological structure and past history of Barbados, and for the first time definitely established the relations of the series of deposits of which it is composed.

Barbados is an island some 21 miles long by 11 broad and rising at one point to a height of 1104 feet It is situated at a distance of 100 miles from the main chain of the Lesser Antilles, from which it is separated by a sea 1500 fathoms deep. It is composed entirely of sedimentary deposits, no volcanic rocks occurring on the island except a little light dust and pumice which was probably ejected from a vent within a radius of 300 miles; the authors, however, suggest that the elevation may have been due to a laccolite. The absence of volcanic rock is a point of importance, as we have been taught on high authority "that all the Lesser Antilles almost without exception are volcanic."

The rocks are divided into four groups: the Scotland series, the Oceanic series, the Coral limestones and the valley deposits and blown sand. The first consists of an irregular series of sandstones, grits, and shales, with some bituminous clays yielding petroleum, resembling those of Trinidad and Venezuela; the whole series is much contorted, faulted and even inverted; they are shown to be more than 600 feet thick, while their base is not seen, and they are unconformably overlain by the succeeding beds. Fossils are very rare in this series, and they are so imperfectly preserved that all the authors can conclude is that they have "general resemblances to the fossils in those deposits of Trinidad which are regarded as Miocene" (p. 15).

The Oceanic series overlie these unconformably; the basement bed is a hard blue limestone, a fact of very considerable importance on the question of the deep-sea origin of the succeeding 300 feet of chalky earths, limestones, Radiolarian marls, and red clays. The evidence of both lithology and palæontology is conclusive as to the deep-sea nature of the deposits; thus the Foraminifera indicate a depth of 1000 fathoms, the Echinoid of more than 1000, while the Radiolaria point to still deeper conditions. The evidence as to age is less satisfactory: the Microzoa are of little value in this connexion; while of the higher fossils the only one that has been fully worked out is a specimen of *Cystechinus crassus*, Greg. The authors, therefore, merely quote the opinion of the describer of this fossil, that it was either of Pliocene or Pleistocene age.

The *Coral Rocks* form a sheet that covers 144 out of the 166 square miles of the island; it is rarely more than 200 feet thick, but it is in places as much as 260 feet. The coral rock is merely a rough coarse-grained limestone; beds of freestone, a very porous building-stone, locally known as dripstone, and some intensely hard compact rock that forms good road-metal, also occur. Much of the coral rock is formed of broken fragments of Corals, Mollusca, and Nullipores. The base of the series is always of loose rubble or half-consolidated coral or marl. In one of the caves opened by the Water Supply Company, the coral rock is seen to rest on a mixture of coral sand and material derived from the siliceous earth: none of the deposits that one might expect to find on Dr. Murray's hypothesis seem to be present, as none such are referred to. The corals and shells examined show that the whole series is of Pleistocene age.

Of the four concluding chapters, one gives an outline of the physical history of the island from the continental conditions indicated by the Scotland series till the recent elevations; a second is devoted to the general configuration and drainage, a point of much interest in connexion with the recent operations of the Water Supply Company, under the able guidance of Mr. E. Easton, C.E., F.G.S., in intercepting the underground water-courses. The final chapters are on the soils and surface deposits and contain an account of the economic products of the island.

The memoir is certainly a most valuable contribution to our knowledge of the geology of the Caribbean area; but it must be judged not so much as a scientific monograph as a popular guide to the authors' geological map of the island. Its treatment of the scientific problems involved is only preliminary to the series of more detailed papers to be published elsewhere. But the work is so simply and interestingly written, and the points upon which further evidence is wanted so clearly indicated, that it ought to stimulate the residents of Barbados to a more careful search of the lower beds, and thus enable the authors to settle more definitely the age of the Scotland series, which is the most important problem that still awaits solution. J. W. G.

## IX.—North American Cretaceous Echinoidea.

Note sur quelques Échinides du Terrain crétacé du Mexique. Par G. Cotteau. Bull. Soc. géol. France [3] xviii. pp. 292–99. Pl. I. II. (Paris, 1890.)

A Revision of the Cretaceous Echinoidea of North America. By W. B. Clark. Johns Hopkins University Circulars, No. 86. 1891. 8 pp.

THE paucity of marine Mesozoic deposits in North America is in striking contrast to the extensive development of those systems in Western Europe; hence every addition to the fauna of those "ages" on the other side of the Atlantic is of great interest to European geologists as supplying further material to assist in the study of the evolution of the same group in the two provinces.

The Echinoidea have been especially neglected; hence both M. Cotteau and Mr. Clark are able to make most valuable additions to the North American fauna; the literature of the group moreover is very scattered and most of the species have been described by men who were not specialists, so that a revision of the genera was greatly needed.

In M. Cotteau's paper is given a careful description of six species from Mexico; two of these, viz. *Diplopodia malbosi* (Ag.) and *Salenia prestensis* (Gras), are characteristic of the European Aptien. Three of the other species are of European genera, viz., *Pseudocidaris saussurei*, Lor., *Holectypus castilloi*, Cott., and *Enallaster mexicanus*, Cott.; the last two are new species; the first was originally based by M. de Loriol on spines, but the test has been described by M. Cotteau. The sixth species is that described by D'Orbigny as *Echinoconus* (*Galerites*) *lanieri*, but for which Prof. Duncan in his

"Revision" established a new genus, *Lanieria*; with this course M. Cotteau fully agrees. The last species may be of Tertiary age, but the others are all Lower Cretaceous.

Mr. Clark's "Revision" contains a list of the species hitherto described, with short notes on the synonymy. The list includes 43 species, of which 19 are new; several old species are merged as synonyms, and some are abandoned as indeterminable. As Mr. Clark does not accept Roemer's genus *Macraster*, not one genus in the list is peculiar to America; while none of the species recorded are found in Europe. *Goniopygus* and *Botriopygus* are now added to the American fauna, and it is interesting to note that the author identifies one species as a *Psammechinus*. The paper is preliminary to a detailed monograph, and its issue was a very wise course, as in a group in which the literature is so scattered, it was the only means of enabling the work to be made fully complete. J. W. G.

## REPORTS AND PROCEEDINGS.

### Geological Society of London.

I.—Feb. 25, 1891.—A. Geikie, Esq., LL.D., F.R.S., President, in the Chair.—The following communications were read:—

1. "A Contribution to the Geology of the Southern Transvaal." By W. H. Penning, Esq., F.G.S.

The following table shows the author's classification of the sedimentary rocks of this region, as compared with those of Messrs. Dunn and Stow and Prof. Rupert Jones:—

| Dunn. (Map, 1887.) | | Stow. | T. R. Jones. | Penning. | |
|---|---|---|---|---|---|
| Coal-measures: *Upper Karoo* (formerly Stormberg Beds, above Upper Karoo). | Carboniferous to Triassic. | *Upper Karoo.* | Triassic Formation. | *High Veldt Beds* | Oolitic. |
| Kimberley Shales: *Lower Karoo* (formerly Upper Karoo). | | ..... | *Lower Karoo.* | *Kimberley Beds.* | |
| *Lydenburg Beds.* | Silurian. | | | *Klip River Series.* | *Megalusbery Formation.* Devonian. |
| | | | | *Witwatersrand Series.* | |
| *Namaqualand Schists.* | | | | *De Kaap-Valley Beds.* | Silurian. |

The De Kaap-Valley Beds consist of schists, shales, cherts, and quartzites, with some conglomerates, chloritic and steatitic beds of great thickness, faulted, according to the author, against the granite. They contain a few obscure Corals, and are provisionally referred to the Silurian.

The Witwatersrand Series consists chiefly of sandstones, shales, cherts, and quartzites, having an estimated thickness of 18,000 feet, possibly formed in a hollow of the granite, and perhaps of marine formation.

The Klip-River Series is formed of shales, flagstones, cherts, and quartzites, with numerous interstratified traps, and is at least 18,000 feet thick. Near its base is the "Black Reef" and a chalcedonite like that described by the author in connexion with the Lydenberg district, which confirms his opinion that this area is formed of part of the Megaliesberg formation. The base of the series is generally conformable to the underlying rocks. The whole of the lower half of the Megaliesberg formation is let down against the north side of the granite south of Pretoria.

The author divides the formation which he described in 1884 under the heading of High-Level Coalfields of South Africa into the Kimberley Beds and the High Veldt Beds. The former thin out eastward, and are overlapped by the latter, the estimated thickness of which is 2300 feet. A volcanic rock overlies the Coal-formation. Near the base of the formation is a bed of loose, calcareous, sandy clay inclosing many waterworn pebbles, some of large size, derived from the quartzites and "bankets" of the underlying formation. The author is convinced that the region was under glacial influences at some time during the long period which intervened between the deposition of the Megaliesberg formation and of the coal-bearing rocks of the High Veldt, which latter, he maintains, are certainly Oolitic; the latter contain *Glossopteris* (?) and Fishes, which he considers to be nearly allied to *Lepidotus valdensis*, the latter being from the Free State.

The High-Veldt rocks are of fluviatile origin, and there appears to have been continuity of fluviatile denudation from the close of the Oolitic period until now.

2. "On the Lower Limit of the Cambrian Series in N.W. Caernarvonshire." By Miss Catherine A. Raisin, B.Sc. Communicated by Prof. T. G. Bonney, LL.D., F.R.S., V.P.G.S.

In this paper the author examines the questions, whether the Bangor beds should be included in the Cambrian series, and how the strata associated with the southern felstone should be classed. The lithological character of the rocks overlying the conglomerate at Bangor is shown to be of little classificatory value, but the apparent discordance between its strike and that of the beds beneath suggests the inclusion of the latter in the pre-Cambrian series, as maintained by Prof. Hughes and Prof. Bonney.

The age of the northern beds must depend, however, to a great extent upon the classification adopted for the Llyn Padarn rocks. It has recently been proposed to regard the felstone of this district as a lava-flow of Mid-Cambrian age, and the beds to the north as lower strata included in the same great series. The author points out as objections to this view:—(1) the enormous thickness of beds, which in that case must be cut out by the supposed Arenig unconformity at Caernarvon; (2) the difficulty of assigning two felsite

masses lithologically similar to two distinct periods; and (3) the occurrence of conglomerates similar to those which are elsewhere admitted to be basal Cambrian. But in addition to these minor difficulties, the theory of a Mid-Cambrian age for the above-named lava is shown to be without foundation. It was supposed that in the Bryn Efail quarry the slaty rocks of the district immediately to the north could be seen in contact with, and altered by, this lava. The author shows that no slate occurs in the quarry, a diabase having apparently been mistaken for it, and that there is no grit in the section which would afford any support to the new theory. The author concludes that the Llyn Padarn felsite is probably, as classed by Dr. Hicks and Prof. Bonney, of pre-Cambrian age. As regards the country to the north, the argument for the new arrangement was based mainly on the interpretation of the Bryn Efail rocks; but as this is seen to be erroneous, the section founded on it does not appear preferable in any way to that published by the Geological Survey.

3. "On a Labyrinthodont Skull from the Kilkenny Coal-measures." By R. Lydekker, Esq., B.A., F.G.S.

The author describes a skull from Jarrow Colliery, which he refers to *Ichthyerpetum*, and names *I. hibernicum*, giving reasons for its specific distinctness from *I.* (*Erpetocephalus*) *rugosum*, Huxley. He compares it with allied forms, and believes that it is a member of the group *Brachyopina* of Miall, and if so that we have a number of forms belonging to a type which is unknown above the base of the Permian in Europe, but which survived to later times in the Indian, Australian, and Ethiopian regions.

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II.—March 11, 1891.—Dr. A. Geikie, F.R.S., President, in the Chair.—The following communications were read:—

1. "Manod and the Moelwyns." By A. V. Jennings, Esq., F.L.S., F.G.S., and G. J. Williams, Esq., F.G.S.

The area described by the authors is on the N. side of the Merionethshire anticlinal of Lower Cambrian rocks, and contains Lingula flags, Tremadoc and Arenig rocks. The authors correct what they think is an inaccuracy of some importance in the correlation of beds in different parts of the range, as interpreted in the map and memoir of the Geological Survey, and trace with greater completeness the position and constancy of the beds of slate in the Arenig series—a point of considerable local and practical importance to those engaged in slate-quarrying. They offer also what seems to them to be conclusive evidence to show the intrusive nature of the great crystalline mass known as the syenite of Tan-y-Grisiau, and to its intrusion are due, in their opinion, the peculiar physical characteristics of the surrounding country. Though in the immediate neighbourhood of Festiniog there is no direct evidence of unconformity between the Tremadoc and Arenig series, it seems probable that an unconformity does exist; for when traced toward the west the Tremadoc beds thin out and the Lingula flags are overlain by Graptolite-bearing slates of Arenig age, while eastward, near Llyn

Serw, the grit comes close upon Upper-Lingula flags. The division of the Arenig volcanic rocks into Lower Ashes, Felstone, and Upper Ashes, while true of some districts and useful as a generalization, conveys an idea of uniformity of strata all round the anticlinal which more detailed examination of different districts does not support.

2. "The Tudor Specimen of *Eozoon*." By J. W. Gregory, Esq.

After careful examination of all the slides and figures, and after consideration of Sir W. Dawson's interpretation, the author is absolutely unable to recognize in the specimen any trace of the "proper wall," "canals," or "stolon passages" which are claimed to occur in *Eozoon*, or any reasons for regarding the calcite bands as the "intermediate skeleton" of a Foraminifer. There are points in Sir W. Dawson's figure which might pass as "stolon passages," but they appear very different in a photograph, and the specimen agrees with the latter.

The author, however, gives reasons for concluding that the case against the organic origin of the Tudor specimen does not rest on negative evidence alone; for though the rock is much contorted, the twin lamellæ and cleavage-planes of the calcite are not bent; and the fact that the crystalline bands cut across the bedding-planes further shows their secondary origin.

The rock in which the specimen was found is not "Lower Laurentian," and is included by Messrs. Selwyn and Vennor in the Huronian.

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III.—March 25, 1891.—Dr. A. Geikie, F.R.S., President in the Chair.—The following communications were read:—

1. "Notes on Nautili and Ammonites." By S. S. Buckman, Esq.

1. *The Position of the Last Septum.*—Mr. Bather's theory of shell-growth in Cephalopoda (Ann. and Mag. Nat. Hist. 1888, p. 300) seems to depend upon the idea that the last septum in the young in *Nautilus* and *Ammonites* was always formed at a proportionately increased distance from the penultimate. This supposition is not borne out by specimens of *Nautilus*, *Witchellia*, *Lioceras*, *Ludwigia*, and *Grammoceras* examined by the author.

2. *Shell-muscles of Nautili and Ammonites.*—Two specimens of Ammonites in the author's collection are marked by impressions which seem to indicate the position of the shell-muscle.

2. "On the Drifts of Flamborough Head." By W. G. Lamplugh, Esq., F.G.S.

The author describes in detail the characters and distribution of the glacial deposits on Flamborough Head, and classifies them as follows:—

| | |
|---|---|
| Alluvial wash, freshwater marls, etc. ... ... ... ... | Recent. |
| Late glacial gravels ... ... ... ... ... ... ... ... | Glacial. |
| Upper Boulder Clay ... ... ... ... ... ... ... ... | |
| Intermediate Series. Stratified beds with bands of Boulder Clay ... ... ... ... ... ... ... ... | |
| Basement Boulder Clay ... ... ... ... ... ... ... | |
| Chalky rubble ... ... ... ... ... ... ... ... ... | |
| "Infra-glacial" beds of Sewerby and Speeton. | |

He discusses their relationship with other drifts, and arrives at the following conclusions:—

1. The glacial deposits are divisible into Upper and Lower Boulder Clay, with an Intermediate series.

2. The Lower Clay is a continuation of the Basement Clay of Holderness, and is the product of the first general glaciation of the area. The Intermediate series passes laterally into the Purple Clays of Holderness, and has been deposited at the edge of the ice-sheet. The Upper Clay includes the Hessle Clay of Holderness, and marks the latest glaciation of this region.

3. The fossiliferous beds of Sewerby ("Buried-cliff Beds") and Speeton ("Estuarine shell-bed") are older than the Basement Clay, and therefore than the earliest glaciation.

4. The glaciation was effected by land-ice of extraneous origin, which moved coastwise down the North Sea, and did not overflow the greater part of the Yorkshire Wolds.

5. Neither the Boulder Clays nor the Intermediate gravels are of marine origin, the shells which occur in them being derivative.

6. The ice-sheet seems to have filled the North Sea basin in this latitude from the commencement of the glaciation until its close. There is no clear evidence here for a mild interglacial period, but only for extensive fluctuations of the margin of the ice.

3. "On a Phosphatic Chalk with *Belemnitella quadrata* at Taplow." By A. Strahan, Esq., M.A., F.G.S. (Communicated by permission of the Director-General of the Geological Survey.)

Two beds of brown chalk in an old pit near Taplow Court owe their colour to a multitude of brown grains. These grains are almost entirely of organic origin, Foraminifera and shell-prisms forming the bulk of them. Mr. Player has analyzed specimens of the brown chalk, and finds that it contains from 16 to 35 per cent. of phosphate of lime. The tests as well as the contents of the Foraminifera seem to have been phosphatized, the phosphate appearing as a translucent film in the former case, and as an opaque mass in the latter. In the case of the prisms of molluscan shells, the whole of the phosphate appears to be in the opaque form. Minute coprolites also occur, together with many small chips of fish-bone, in which Dr. Hinde has recognized lacunæ, while some have been identified by Mr. E. T. Newton as portions of fish-teeth.

Mr. Player observes that the phosphate occurs in such a condition that it would not improbably serve as a valuable fertilizer, without conversion into superphosphate. This condition is probably due to the partial replacement of carbonate of lime by phosphate in the organisms. The removal of the remaining carbonate leaves the phosphate in a honeycombed state, peculiarly favourable for attack by the acids in the soil.

The author comments upon the resemblance of the deposit to the phosphatic chalk with *Belemnitella quadrata* which is largely worked in Northern France, and upon a less striking resemblance with that of Ciply, which is at a higher horizon.

## CORRESPONDENCE.

### DYNAMIC METAMORPHISM OF ROCKS.

SIR,—It is from no mere love of controversy that I should like just to say, in reply to Mr. Hutchings' query (GEOL. MAG. for April, 1891, p. 168), that—while I am unable to appreciate unnecessarily realistic play upon a metaphor which is no invention of mine, and have no right to quarrel with him if he is still smitten with the charms of the fallacy to which I referred—it seems to me that, to apply the term "*dynamic* metamorphism" to a rock whose internal structure shows no signs of *differential* movement (under pressure) of its constituent particles, is only another instance, added to those with which we are already too familiar in petrology, of the abuse of technical language. Further, Mr. Hutchings seems to me to surrender the point in the very next paragraph, if the Coal-seams, by undergoing compression, have acted as buffers to relieve the fire-clays of that portion of the mechanical force which otherwise might be expended upon them to induce a cleavage-structure, in those larger movements, to which the Coal-measures of Northumberland as a whole have been subjected. There seems to be some confusion between *dynamic* agencies of change in the internal morphology of a rock and what Prof. Judd has described as *static* (GEOL. MAG. 1889, Dec. III. Vol. VI. pp. 243 *et seq.*), the potency of of which I had previously recognized in my Thesis (see *Chem. and Phys. Studies*, etc., pp. 53–55, 93) to the extent of inducing such metamorphic alteration in chemical compounds previously formed as might complete their individuality *quâ minerals*.

This being so, I may be allowed to repeat my thanks to Mr. Hutchings for his most valuable contributions of *facts*, the full value and bearing of which will perhaps be better seen, when the present acute stage shall have passed of that "pressure on the brain," under which English petrology would seem at present to be suffering.

WELLINGTON COLLEGE, BERKS,
*4th April*, 1891.

A. IRVING.

## MISCELLANEOUS.

DISCOVERY OF LOWER SILURIAN FISHES.—At the meeting of the Biological Society of Washington, on February 7th, 1891, Mr. Chas. D. Walcott, of the United States Geological Survey, announced the discovery of numerous dermal plates apparently of fishes in a formation believed to be of Trenton age, near Cañon City, Colorado. Mr. Walcott contemplates presenting a full account of the subject to the Geological Society of America at their forthcoming meeting in Washington in August next.